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SEPTEMBER 1955

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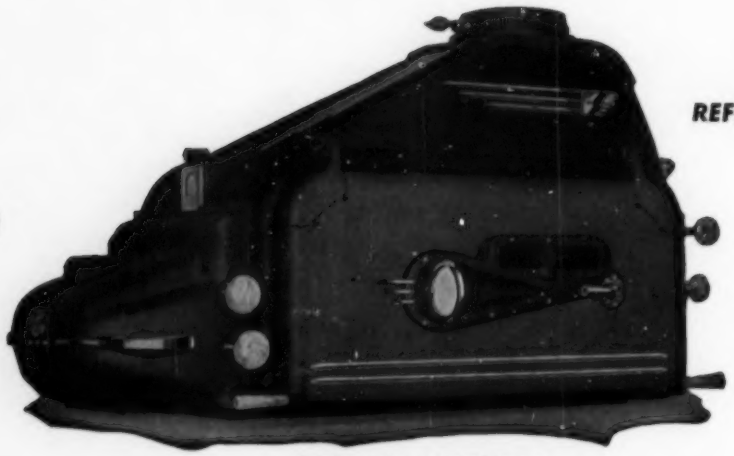

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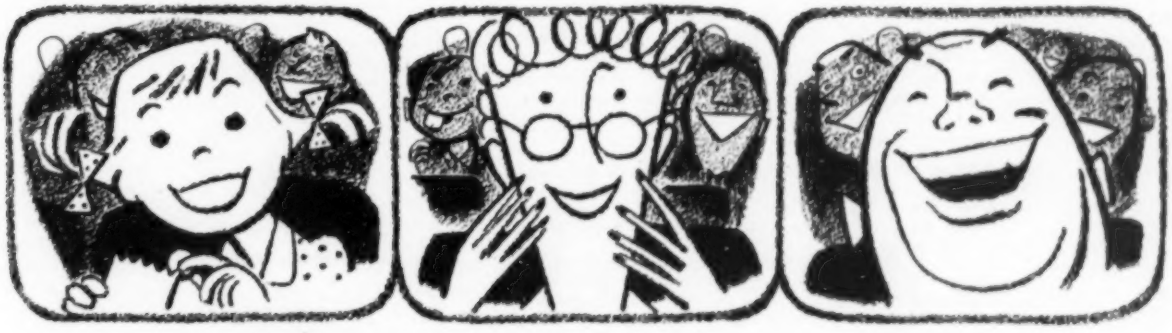

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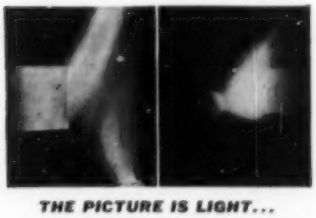

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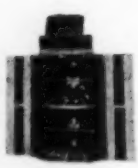

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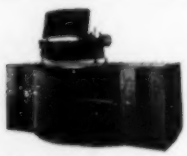

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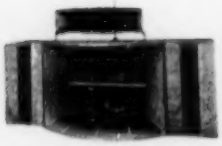

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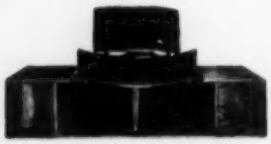

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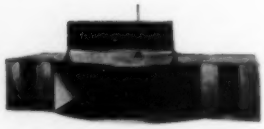

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9E

Monthly Chat

Lively TESMA Forum Planned

THE LARGE group of projectionists planning to attend the coming TESMA Convention in Chicago probably have a treat in store for them. Last year, the widely publicized new processes forum turned out to be almost the opposite of an open meeting. The long program of technical papers, read by engineers and others, almost suffocated the forum and left practically no time for questions from the floor or discussion of immediate technical problems. This year things will be different. Merlin Lewis, executive secretary of TESMA, tells us that it has been decided to restrict the number of papers as far as possible, and to concentrate on seeing that the forum remains a forum. Instead of reading papers, the battery of experts from the projector and sound manufacturing plants and Hollywood studios will devote their time to answering questions from the floor. So get ready men!

A Look Into the Future

A PREDICTION that from now on there will be a "double standard" for projection equipment in motion picture theatres was made recently by R. Edward Warn, a vice-president of the Westrex Corp. Within a short time, he thinks, the industry will have come to accept the existence of two distinct types of theatres. One type will be the small number of roadshow or de luxe houses which will specialize in elaborate pictures processed on 70-mm or horizontal-running film for unusual projection effects on giant screens. This type of theatre will, of course, form only a tiny percentage of the total number. The other type will include the great majority and will continue to find its needs amply satisfied by standard-width film and 35-mm projection equipment of high quality.

It is felt by Mr. Warn that utilization of new projection and sound developments by the de luxe houses will permit continuing experiment and pave the way for additional technical progress, which will eventually be passed along to the smaller theatres. In any case, the double technical standard for projection technique will forever end the short-sighted freeze on progress that penny-wise executives imposed on the motion picture industry. This freeze was in effect from the time of the introduction of sound back in the late Twenties until exhibitors were forced to accept the recent changes required by the new processes.

Drive-In Screen-Brightness Survey

WE ARE glad to hear that the SMPTE has completed a preliminary survey of screen-brightness levels at drive-ins with a view toward eventually recommending permanent standards similar to those existing for indoor theatres. Until recently the drive-in was a sort of technological stepchild with many screens too dim to be worth watching. The report by the SMPTE will be published shortly in IP. In it the Society pays tribute to the various projectionists who assisted by supplying information.

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INTERNATIONAL PROJECTIONIST

VOLUME XXX SEPTEMBER 1955 NUMBER 9

Recent Trends in Shutter Design For Theatre and Tv Projection

By ROBERT A. MITCHELL

The high optical speed of modern projection systems, and the great heat they generate, test the ingenuity of those who design shutters. Tv has brought additional problems.

OPTICAL efficency of a "film-reproducing system"—a theatre projector, for instance—is due largely to the design and placement of the optical components involved. These, in ordinary motion-picture projectors, are the arclamp mirror or condensing lens and the objective lens which focuses the tiny film photographs upon the screen in highly magnified form.

The older projectors utilized comparatively inefficient optical components, as both the arclamp condensing elements and the projection lenses were quite small in size. As a photographer might say, the old-time projectors were "slow," while modern projectors, with their large lamphouse mirrors and $f/2$ to $f/1.5$ objective lenses, are relatively "fast."

Light Bottlenecks

But there are several factors besides mirrors and lenses which influence the light-transmission efficiency of a film-reproducing system. The film aperture, that tiny rectangular window through which all the light that reaches the screen must pass, is such a factor. So also the revolving "occulting"* shutter which, in the average theatre projector, cuts off and wastes approximately half of the available illumination.

Because the shutter wastes so much of the light, it may seem advisable to redesign the projector in such a way that no shutter is needed. Before this difficult feat can be intelligently attempted, however, the twofold function of the shutter must be thoroughly understood.

The best way to understand what the shutter does is to remove it from a projector and show a film. When this is done it will be seen that the picture is approximately twice as bright as before, but it is also marred by flickering streaks of light which emanate from all bright objects in the picture. These streaks are known as "travel ghosts;" and, of course, without any shutter at all, the travel ghosts are very bright and extend all the way from the botttom of the screen to the top while the film is running.

Travel Ghosts

Travel ghosts are caused by the movement of the film as the intermittent sprocket pulls it down past the aperture at regular intervals, one frame at a time. If the action could be slowed down sufficiently without burning the film, this frame-shifting process would be seen on the screen, the pictures moving up from the bottom of the screen because the lens turns the image upside down.

But in actual projection without a shutter, the individual frame-shifts follow one another much too rapidly to be seen as periodic movements of the film. The eye, unable to follow the shifts, perceives only blurry streaks of travel ghost superimposed over the picture.

The shutter, then, is obsolutely necessary in the conventional projector to cut off the light and "occult," or hide, the projected image of the film every time the intermitttent movemen pulls the film down past the aper-

* The word "occulting" means to hide, and is used here to describe the action of the shutter in concealing the film during the pull-down period.

ture. But here again the rapidity of the process deceives the eye. Even though the screen actually goes dark at regular intervals, only a discontinuous series of still photographs being projected, the "persistence of vision" of the eye carries the images over through the intervals of darkness. Thus arises the illusion of a continuous motion picture.

How Flicker Occurs

Since there are 24 pulldowns of the film every second in standard projection, the occulting shutter must cut off the light at least 24 times a second to eliminate travel ghost. However, if a shutter is designed to hide or occult the film *only during the pulldowns* (that is, *only* 24 times a second), a terrific flicker will be produced. A cutoff frequently of 24 cycles per second is evidently too low to permit persistence of vision to "fill in" the intervals of darkness and create the illusion of a continuously illuminated picture.

Flicker in motion pictures is a complicated matter because it depends not only on the frequency of the cutoffs, but also on many other factors, the most important of which is the brightness level of the projected picture. It is definitely known that cutoff frequency must be increased when the brightness of the picture is increased, if flicker is not to become perceptible. Nearly everyone has noticed how the highlights in a motion picture, such as snow and clouds, often flicker while darker areas in the same picture are quite free from flicker.

Now, even if there are only 24 cutoffs per second, flicker can be eliminated by sufficiently reducing the brightness of the picture. Unfortunately, however, the highlight brightness must be no greater than ½ footlambert to conceal flicker when the cutoff frequency is only 24 cps. A highlight brightness of ½ footlambert corresponds to screen illumination of about 1 footlambert when the projector is run without film. This is far too little light for comfortable viewing.

Drive-in Light Levels

Screen brightness in many drive-in theatres ranges from 3 to 4 footlamberts, corresponding to highlight brightnesses of from 1½ to 2 footlamberts. These brightness levels tolerate cutoff frequencies as low as 28 - 32 cps., which means that the shutter *must* be speeded up to these frequencies to make flicker virtually imperceptible to the normal observer.

The rather low levels of screen illumination acceptable in drive-in practice are definitely inadequate for quality projection in regular theatres. The patrons of indoor theatres demand brighter pictures. Tests made with a wide variety of standard 35-mm. release prints, both black-and-white and color, indicate that screen illumination should be no less than 10 footlamberts nor more than 30 footlamberts for satisfactory projection. These screen brightnesses correspond to highlight brightnesses of from 5 to 15 footlamberts, and require shutter cutoff frequencies at least as high as 40 to 45 cps.

A 24 cps.-shutter is clearly unsuitable for projecting movies at screen-light levels of 10 to 30 footlamberts. Speeding up the projector to raise the cutoff frequency is out of the question. Fortunately, the general effect of faster shutter rotation may be obtained by adding a second blade. This expedient produces 48 cutoffs per second when film is projected at the standard rate of 24 frames per second.

Both blades of the 48-cps. shutter have the same angular width and are positioned symmetrically to give openings of equal angular width. One blade cuts off the light during the film pulldown, and the other blade cuts off the light for an equal interval of time in the middle of the "dwell" period when the intermittent sprocket is "at rest" and the film is motionless over the aperture. The first blade thus eliminates travel ghost, while the second blade eliminates flicker by increasing the cutoff frequency to 48 cps.

It should be clearly understood that the second, or "balancing," blade should have the same width as the first, or "master," blade. If the balancing cutoff is of shorter duration than the pulldown cutoff, more or less 24-cycle flicker will be produced.

Any shutter blocks the passage of a certain amount of light, and a 48-cps. shuttter wastes more light than does a 24-cps. shutter. The light-transmission of a shutter can be increased by trimming the blades to a narrower width, but we must not forget that the blades should be wide enough to hide the image during the entire pulldown process. An intermittent movement that pulls the film down sluggishly requires wider shutter blades than a quick-acting movement does.

Light Losses

The standard geneva movement used in most theatre projectors has a pulldown ratio of 3:1, meaning that this type of intermittent gives a dwell period 3 times longer than the pulldown period. If a 24-cps. shutter is used, occulting the image only during the film-pulldowns, only 25% of the light will be blocked off. But when a balancing blade is added to increase the cutoff frequency to 48 cps., the loss of light is fully 50%.

In actual projection practice the

(Continued on page 33)

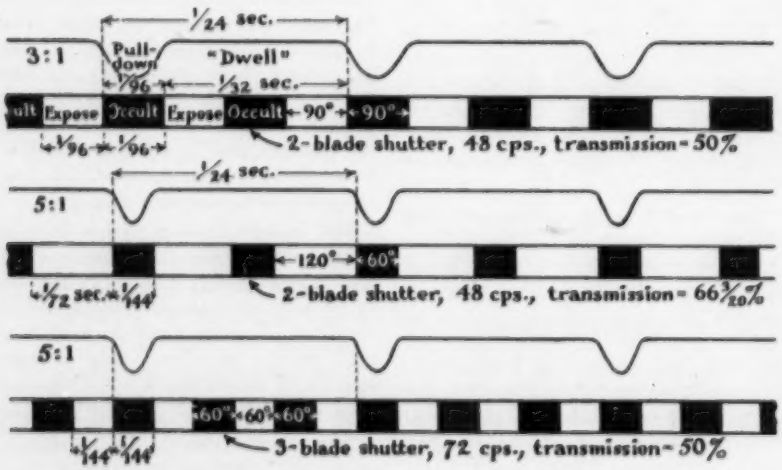

FIG. 1. Diagram illustrating the relative periods of exposure and occultation by three types of shutters used on motion picture projectors. The two shutters having 60-degree blades are suitable for use only with intermittents having a 5:1 ratio of "dwell" to "pulldown" time. The standard 3:1 geneva movement requires 90-degree shutter blades.

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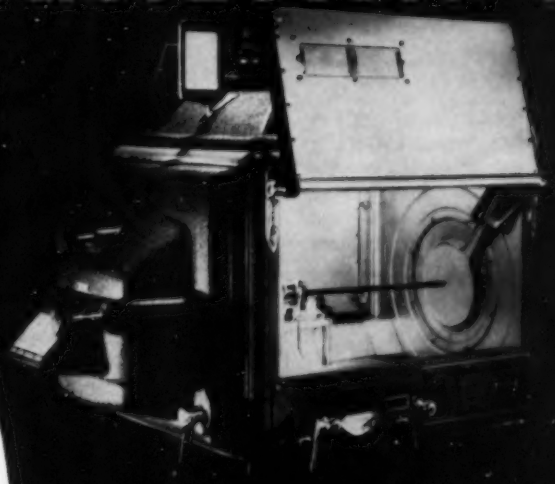

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Imaginative use is made of 16-mm equipment at new California amusement park to project picture on screen that curves to full circle, and to provide illusion of space-ship travel.

Circarama: Spectacular 16-mm Presentation at Disneyland

This projectionist is adjusting his picture from behind the screen even though it isn't rear projection. It's the Circarama at Disneyland where the screen curves to a full circle, and eleven 16-mm projectors are required to fill it. Each projector sends its beam through a port in the black masking separating the panels of the screen. All the beams criss-cross in the center of the theatre and each beam lights the panel directly opposite its projector. The magazine shown lying flat at right of the projector is known as the Busch continuous magazine. It can continuously project a loop of film as much as 400 feet in length without any attention from the projectionist.

MOST members of the craft have heard by now of the elaborate "Disneyland" amusement park recently opened near Anaheim, California, in the suburbs of Los Angeles. However, after crediting Walt Disney for his imagination and good business sense in devising this money-making sideline for himself, they probably dismissed Disneyland from their minds as a big roadside attraction for kids with no relation to the projection craft.

Nothing could be further from the truth! 16-mm projection equipment is being widely used at Disneyland in an original manner that points the way to interesting and lucrative new fields of employment for projectionists.

"Tomorrowland," is a section of this unique 160-acre amusement park which is attracting thousands of tourists daily with a clever preview of what the world will be like in 1986. This preview is accomplished primarily by the imaginative use of 16-mm motion picture projectors, often linked together in synchronization for displays that make the ideas of the Cinerama people seem tame.

The Ultimate in Screens

In one of the exhibits visitors are completely surrounded by a motion picture screen that covers the entire 360 degrees of a 40-foot-diameter circle. In another they are gripped by the illusion of blasting off in a rocket ship for a trip to the moon. Sound effects and rear-projected images in the windows or "scanners" of the simulated rocket ship create the effect of leaving the earth. A third exhibit explains with the aid of an unusual projection system how oil formed thousands of feet below the surface of the earth and how drillers of the future will bring it to the surface.

The most ambitious of the motion picture systems developed for Disneyland is one called Circarama which projects a continuous picture on a screen that curves to a full circle. Eleven Model 25 Eastman Kodak 16-mm projectors, using 1000-watt filament lamps and synchronized by Selsyn interlock motors, fill the eleven 8-foot by 11-foot panels of the round screen.

The feature presented is a travelogue called "A Tour of the West," sponsored jointly by Disney and the American Motors Corp. Admission is free with American Motors footing the bills for the advertising value of the show.

Although on a much smaller scale, Circarama goes even further than the well-known Cinerama in creating an illusion of reality for sweeping, panoramic scenes. Even so worldly-wise an observer as Tom Pryor, Hollywood correspondent of the New York Times, wrote: "the effect of viewing a motion picture that is going on all around you is fantastic. Particularly overpowering is the sense of motion, or moving with the picture." One of the scenes is a 90 mile-an-hour auto ride along Wilshire Boulevard in Los Angeles.

Projection Problems

The original plan for projecting Disney's Circarama involved projection from a gondola suspended in the center of the small theatre, but when it came time to draw blueprints, it was found that lenses of

Disneyland audience above is watching the Circarama screen that curves to a complete circle 40 feet in diameter. Notice how the spectators are looking in all directions, and also notice the small projection ports located in the black masking area between the panels of the screen. The projectors behind these ports fill the panels of the screen on the other side of the small theatre. Only part of the screen is visible in this illustration. Eleven Kodak Model 25 projectors are used to complete the circular picture.

such wide angle would be required for the short throw that the picture would be badly distorted.

After some thought it was decided to employ a "donut" shaped projection room that stretched completely around the back of the screen. Each of the 11 projection beams emerge from small ports cut in the six-inch-wide masking strips that separate the panels of the screen (see illustration).

Each beam fills the panel directly opposite its projector after criss-crossing the other beams. The audience does not interfere with the projection beams and is not bothered by the glare because both screen and projectors are raised a considerable height off the floor.

It was decided early to sidestep the problem of exactly dovetailing the edges of the 11 projected images that make up the circle. This is a complicated technical problem which is not completely soluble even with the finest 35-mm projection equipment, and has always plagued the engineers of Cinerama. Six-inch masking strips are used by Disney between the sections of the circular picture. It is believed that these strips are noticed only slightly by the audience. In any case they provide the space needed for the projection ports.

Synchronization of all 11 projectors was necessary. Eastman Model 25 projectors are driven with synchronous motors when furnished from the factory and, once started, remain in exact frame to frame phase under the precise control of the 60-cycle frequency power system.

Selsyn Interlocks Used

Left to themselves however, these motors would not start or stop in precisely timed relation to each other. For this reason Selsyn interlocks must be used on each of the 11 projectors to control the starting of the synchronous motors. The Selsyns deliver no power to the motors after they have reached the proper speed. The projectors are then driven by their own synchronous motors. Selsyn interlocks, needless to say, are familiar to projectionists involved in the late but little lamented 3-D splash of a couple of years ago.

The specific job of designing the Selsyn controls for all the 11 projectors and a sound reproducer was delegated by the Disney studio to J. C. Urban, head of Urban Engineering, Los Angeles. Urban worked in consultation with Dr. Edwin C. Fritts, the Kodak staff physicist who headed design and development on the Eastman Model 25 projector.

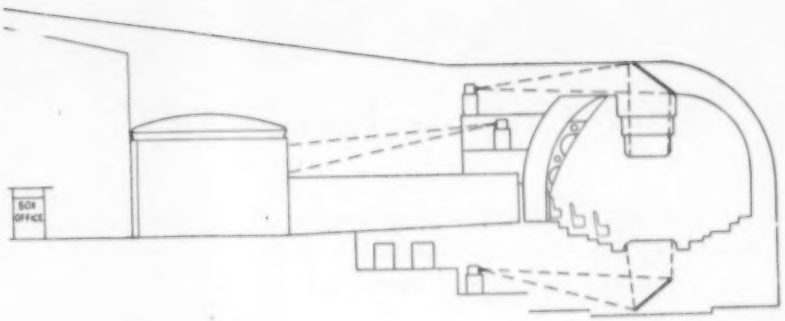
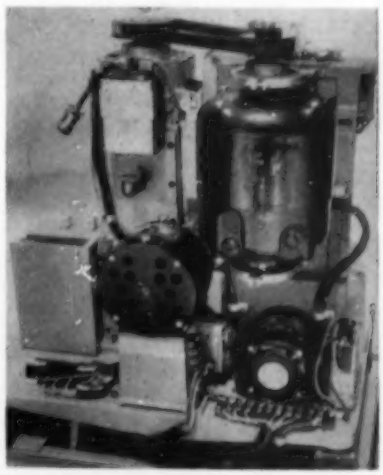


Diagram of another Disneyland theatre—the one where the "Trip to the Moon" takes place—is shown above. The room at right is built to resemble the interior of a rocket ship. The "take-off," projected on the screen at lower right, shows the rocket flames and the receding California coast line. Layers of clouds and finally the Moon itself are projected on the upper screen at right. Sound effects and vibration of the room help to create a powerful illusion. In the other room shown at left, waiting customers are "briefed" by a short film on what a ride in a rocket ship will be like.

It was also attempted to set up the projectors so that they would run as consistently and as automatically as possible. The two most likely show stoppers were felt to be film breakage and burnt-out bulbs.

A micro-switch on each projector guards against time-consuming snarls when a film break occurs. This switch rides over the film as it is wound back into a Busch continuous magazine. If the film breaks the switch closes and turns the projector off instantly. The short show is completed with one panel of the circular screen dark.



Close-up of one of the 11 synchronized 16-mm projectors used for the Circarama presentation. The large black unit in the foreground is the Selsyn interlock motor which is linked by belt drive to the projector's vertical drive-shaft. The motor that can be seen slightly lower and to the left is the standard synchronous drive motor of the Eastman Model 25 projector. The third motor beneath the Selsyn unit is needed in the Circarama installation to drive the projector back into line if it should fall behind in synchronization during a show.

The Busch continuous magazine mentioned above is a device generally used for 16-mm continuous projection systems where advertising sales messages and similar film material is shown continuously on relatively short loops of film. This magazine, which may be seen in the top illustration on the first page of this story, can take loops of film as long as 400 feet, enough to accomodate the Circarama travelogue. Equipped with these magazines, all 11 projectors can be operated continuously from a central control panel.

Automatic Bulb Changer

The burnt-out-bulb problem is solved automatically by a lamphouse arrangement that moves a new bulb into place and switches it on when the filament breaks in the operating bulb. This feat is accomplished by a relay held in place by the current passing through the lamp filament. When the filament breaks, the current holding the relay stops, and the relay snaps over to an alternate position, setting up a contact which carries current to a small motor mounted directly above it.

This motor activates a gear which revolves the rotary lamp housing.

(Continued on page 31)

A Stereophonic Sound System That Utilizes Haas Effect†

A method is suggested for employing a theatre's existing single-channel sound reproducer to reinforce a small two-channel stereosound system.

By **BRUCE P. BOGERT**
Bell Telephone Laboratories

CURRENT interest in stereophonic sound systems, both in the motion-picture industry and more recently in radio broadcasting and the high-fidelity field, makes it worth while to consider all methods of conveniently improving the spatial recognition of sounds. One such method will be discussed here and has particular application to the motion-picture theater sound system, as it involves the use of a large speaker to supply the required acoustic level, with lower power loudspeakers to produce the spatial effect.

In the ordinary stereophonic loudspeaking sound system, separate microphones pick up the sound from two or more locations, and the signals are transmitted or recorded in some fashion, to be reproduced by means of loudspeakers spatially separated. In a typical case, three microphones are used, with their output recorded on three soundtracks. These soundtracks are played back into three loudspeakers, located at the left side, the center, and the right side of an auditorium stage. Each of the sound channels has the same power capacity, in general, since the maximum sound-level requirement for each is similar.

Time Delay Inserted

The method to be discussed makes it possible, by inserting a small time delay in one channel, to reduce the power capability of the other sound-reproducing channels. We consider only the sound-reproducing part of the entire system, and suppose we have, for purposes of discussion, a recorded or live source of stereophonic sound material in the form of a mechanical magnetic tape, soundtrack or group of electrical signals. In particular, let us consider a 2-channel system employing loudspeakers on the left and right of an auditorium stage, as shown in accompanying illustration.

We combine the signals of the channels, delay them from 10 to 35 msec., *(a millisecond or one-thousandth of a second)*, and feed a central loudspeaker with this delayed composite signal, all in addition to the regular stereophonic system. The effect of the additional centrally located sound source is to increase the sound level in the auditorium without appreciably altering the spatial localization due to the binaural effect.

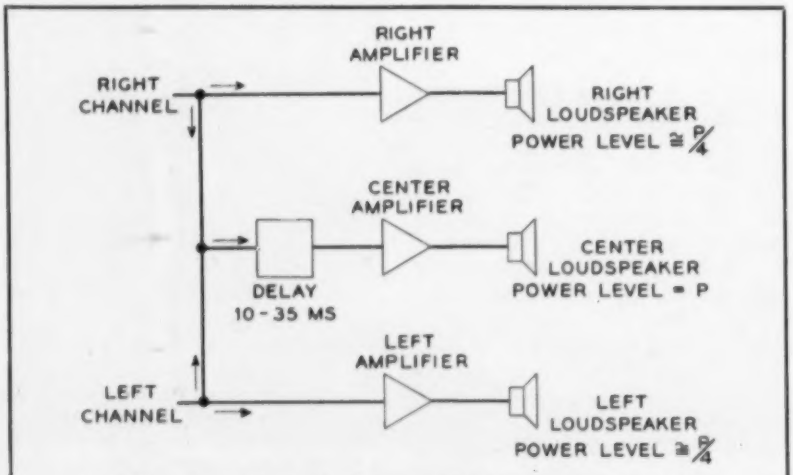
The reason that this is possible appears to be due to the so-called Haas effect. Haas made studies of the intelligibility of speech with various time delays between the direct sound and an echo. When the delay between the direct source and the delayed (echo) source is small (1-30 msec), the apparent source is the direct one, and the delayed source does not appear to be operating, except in that it contributes to the total loudness. This effect is independent of the location of the sources, and the delayed source must be as much as 10 db *(decibels)* more intense than the direct one before the delayed source is perceptible as such.

Limits of Delay

If the delay is greater than some critical value, the delayed source becomes obtrusive, and the effects described above disappear. The critical value ranges from 40 to 100 msec for speech, depending on a number of factors including the relative intensity and the frequency spectra of the direct and delayed sources.

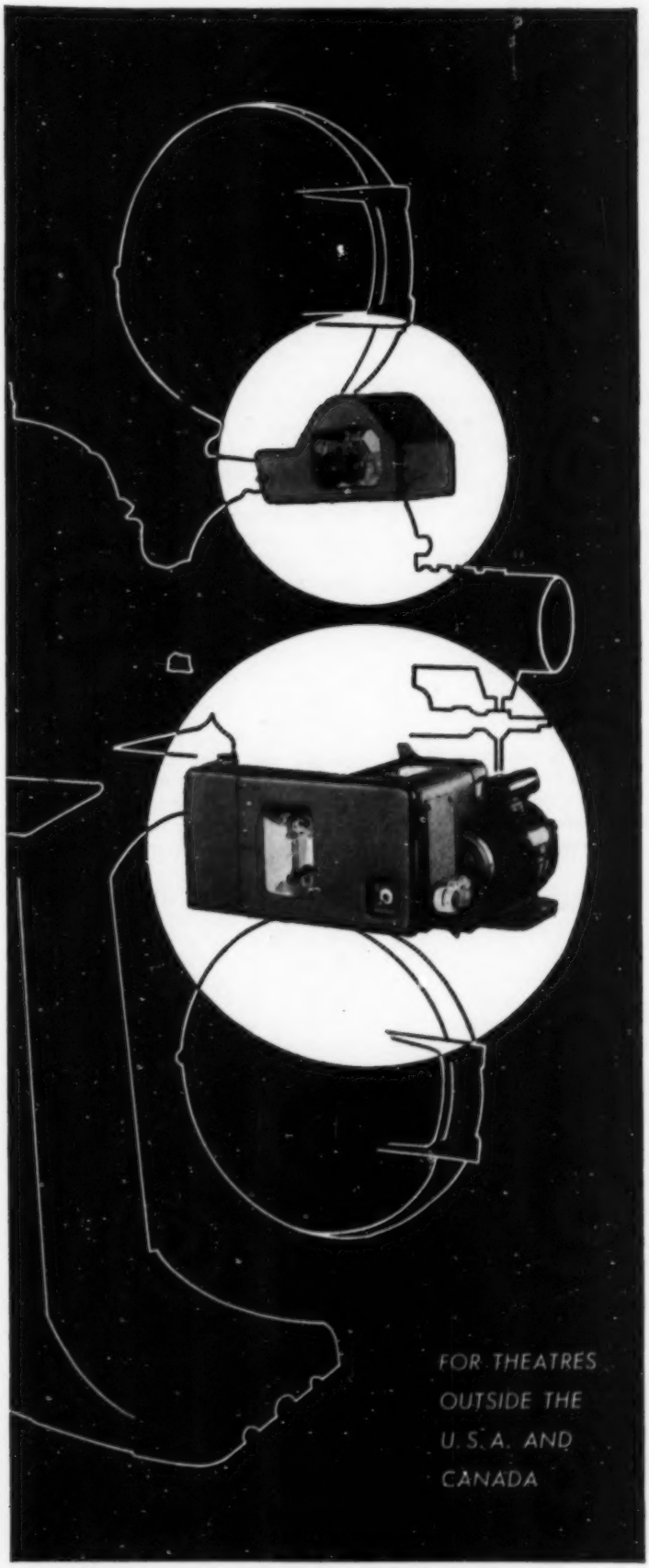
A test was made of this method in the auditorium at the Murray Hill Laboratory of Bell Telephone Labs. A binaural magnetic tape of classical orchestral music was used as a source. The tape was reproduced on a dual-track magnetic tape recorder, and the two outputs were amplified and connected to the left and right loudspeakers behind the auditorium stage.

The two amplifier outputs were also mixed and connected to a recorder-reproducer machine that could be adjusted to operate at a tape speed of either 30 or 60 ips *(inches per second)*, providing a delay between the recorded and reproduced signal



Two-channel stereophonic sound system with added combined signal sent through a delaying circuit to a center speaker. It is thus possible to raise volume without injuring the stereo effect from the two side speakers.

† Journal of the SMPTE, June 1955.



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of either 69 or 34.5 msec, respectively. The frequency response was partially equalized for the 60-ips tape speed. The equalization for a tape speed of 60 ips was not particularly effective for the lower speed. The signal-to-noise ratio for the 60-ips tape speed was about 35 db.

The delayed output was fed into the power amplifier driving the center speaker in the auditorium. By varying the delay-unit reproduce gain, the power output of the center speaker could be adjusted from zero up to 15 or 20 db greater than the output of the left and right loudspeakers.

With the binaural program material, the relative levels were equalized from the left and right speakers, with the center one inoperative. Using a delay of 34.5 msec, the level of the center speaker was raised gradually until observers in the center of the auditorium could just notice the presence of sound emanating from the center speaker. The program source was then replaced by an oscillator feeding one of the binaural channels only. The difference between the sound levels of the center speaker and the other was measured, and it was found that the level of the center speaker was from 8 to 12 db higher than that of the left or right one.

Limitations of System

Further listening tests with more observers indicated that a program level in the center speaker 8 db above that in the left and right speaker was not noticed in the treble range, but the apparent position of the bass instruments seemed to move toward the center with a level difference greater than 5 db.

When the delay was changed to 69 msec from 34.5 msec, by a speed change in the delay unit from 60 ips to 30 ips, the stereophonic property of the system could no longer be observed. The sound appeared to come from the center speaker only, and the overall effect was that of a standard single-channel sound-reproducing system.

The lower relative levels of the left and right channels with respect to the center one could most easily be observed when the program material radiated from the center speaker was not the same as that radiated from the left and right ones. This could be done by using the delay unit as a tape

(Continued on page 31)

Versatile New Simplex Sound Systems

NATIONAL Theatre Supply now has available a new series of Simplex XL sound systems designed especially for theatres with outmoded optical sound and for those theatres where modern magnetic stereophonic sound is desired.

The new systems provide regular optical operation from existing optical soundheads and exciter lamp power supply, while obsolete optical sound components are completely replaced. If a 4-channel stereophonic sound installation is purchased, the existing power amplifier may be incorporated in the new system if desired. The new systems are known as the Simplex XL-500 line.

Both optical and magnetic controls are integrated so that a single sound changeover box at each station provides for both stereo and regular changeover. Undesirable duplication of optical and magnetic changeover controls on the front wall are eliminated by a compact new control cabinet.

A valuable feature of the new systems is the unique changeover setup which allows the projectionist to switch from optical to magnetic, *vice versa*, or to non-sync merely by pressing one button at changeover time. This is possible because with the new control system for the XL-500 the projectionist can preselect the type of sound desired while a reel is running.

Emergency Safeguards

Another important feature is a conveniently-located emergency selector switch which will provide for standby operation under all conditions. If necessary, stereo sound from the center channels can be mixed with the left and right channels. Sound from the left and right channels can be mixed into the center channel only. It is also possible to play regular optical sound through all three power amplifiers and backstage speakers.

New Simplex sound control panel combines optical and magnetic controls.

Built-in facilities for the non-sync input are also provided as was mentioned above. During the last reel of the show, the system pre-selector switch is set at "non-sync," and changeover to non-sync is accomplished at the end of the reel by depressing the non-sync changeover button located on the control box.

The same volume control is used for both regular optical and magnetic stereophonic sound. A separate volume control is provided for the fourth channel so that auditorium effect speakers, where installed, can be closely regulated to suit the program.

Compact Control Panel

All operating controls are conveniently located on the front wall of the projection room, and all except the changeover buttons are located on the front of the compact control cabinet. Provision has also been made for the addition of a third projector, with either optical sound or both magnetic and optical. Plug-in optical and magnetic pre-amplifiers provide for easy replacement and service.

This packaging of previously separated system components in a single control cabinet takes up a minimum of wall area and saves projection room space for any additional equipment that may be needed in the future.

A glance at the accompanying illustration will show that the control cabinet is both compact and complete. At top center can be seen three lights that indicate the type of sound being played—regular (optical), stereo or non-sync. The non-sync changeover button is located directly beneath its light. Below this button is the pre-selector switch which enables the projectionist to set the type of sound for the next reel at a convenient time before the changeover.

At lower right is the emergency switch which makes it possible to play the sound from the center horns over the left and right speakers, and *vice-versa*, if necessary. It is also possible by means of this switch to play optical sound over all three horns at the same time, thereby avoiding a drop in sound level when optical follows magnetic sound. The center switch regulates volume of the stage speakers, and the left switch regulates the volume of auditorium speakers.

Recent Developments in Anamorphotic Systems

This is the final installment of an inclusive article on the development and practical application of anamorphotic lens systems. It was first presented before the British Kinematograph Society.

By G. H. COOK

Member, The British Kinematograph Society
Technical Staff, Taylor, Taylor and Hobson, Ltd., London

NOW consider the projection lens itself. Poor definition arising from poorly-corrected projection lenses is *magnified* by the anamorphotic attachment in the *same proportion as the expansion ratio.*

To demonstrate this, an image was screened by the type of projection lens which has been standard cinema equipment for a considerable number of years. It was pointed out that although its simple construction provided an adequate standard of definition in the centre of the screen, field curvature and astigmatism set a limit to definition at the edges.

Such marginal errors enlarged by anamorphotic attachments are not acceptable on very large screens. The need for improvement has resulted in the introduction of a new range of lenses of high definition. The degree of improvement now available was demonstrated by a screen image projected with a new lens of the same focal length.

The development of anamorphotic systems is still in its infancy, but as far as the exhibitor is concerned, the equipment now available for use on standard projectors will be adequate for a number of years.

Release Print Processing

The most severe optical problems occur in the processes used to produce release prints. When attachments which function in the described manner are used at the camera stage to record on the negative a compressed picture, they have to provide angular fields of view considerably greater than those required in projection. To add to the difficulties, the camera attachment is also required to give good definition over a considerable range of object distances from infinity to close-ups.

At present it is thought that cylindrical types of attachments are the only constructions that can perform under such extreme conditions and they are being developed in forms which utilize more complex and more numerous components compared with the relatively simple constructions used for projection.

The use of large anamorphotic attachments on a studio camera and the associated loss of light by absorption and scatter presents its own problems. Small studios may have limited camera and processing facilities, thus it appears that the use by them of camera anamorphotic attachments provides the easiest method of producing anamorphotic prints.

Future Developments

On the other hand, the larger studios are not always limited in this manner, and, looking into the future, it may be that they will use cameras with larger negative areas, such as VistaVision, to photograph wide-angle scenes in the usual way. The straightforward negatives so produced can then be compressed at an optical printing stage to provide compressed release prints for projection. The advantages of such a process would be:

1. The use of normal type camera lenses avoiding the light losses, definition losses and extra bulk arising from anamorphotic attachments.
2. The use of larger negative areas whose grain and definition is improved by reduction printing.
3. The use of anamorphotic systems at the printing stage where the angular fields to be covered can be small and where they need only work at fixed conjugate distances, and
4. The ability to use one negative for the subsequent production of release prints compressed in any ratio to suit any screen aspect ratio or, alternatively, for the production of normal prints.

When it is realized that positive emulsion has finer grain and can *store more picture information* than negative emulsion, the advantages of optical reduction between negative and positive becomes obvious. It has in fact been well demonstrated in the VistaVision process and the advantage applies equally well to anamorphotic printing.

Vertical Graininess Reduced

Anamorphotic projection assists the visibility of a screen picture by reducing *vertical* grain because the higher projector gate aperture and larger film picture needed less vertical magnification.

Another sample image obtained by a large straightforward negative having been compressed *horizontally* in printing, and the resultant positive projected anamorphotically, reduced the horizontal grain so that grain was reduced in *all* directions to give a further improvement in picture visibility.

Discussion on Foregoing:

MR. CRICKS: First, on this question of light transmission from the small and large apertures. A point which is often overlooked is that one can reduce the size of the gate spot for the wide-screen picture. Mathematically, it appears that there is no difference in screen brightness for any ratio, squeezed or anamorphotic. My limited experience seems to bear this out.

Second, Mr. Cook did not mention the mirror system which has the effect of being able to cure the curvature distortion inherent in the curved screen. Can Mr. Cook explain how that occurs? It seems very mysterious to me.

Gate Area Vital Factor

MR. COOK: On the first point, I think you are suggesting that the focus of the arc crater can be different for smaller and larger gate. I am not qualified to give an opinion on that. Certainly it would appear that the effect does exist, but I am doubtful whether it can equalize illumination passing through two gate areas where one is double the area of the other.

As for the mirror system, this works on a

(Continued on page 29)

After the Last Shot Is Made The Technicians Take Over

It takes three months of effort by film editors, and lab and sound technicians to turn a crude work print into a polished feature film. This article is reprinted through the courtesy of the *International Cinematographer*.

By ALLAN BALTER
20th Century-Fox Studios

AFTER the final scene has been shot on a production, the tremendous aggregate of talent and know-how whose labors fall in the general classification of "post-production" takes over.

The twelve to fourteen weeks that elapse between the final "Print it!" and the day the picture is given its first preview is a sort of mysterious hodge-podge of technical activity about which many who are outside the very top production offices of the studios know little. Invariably there are added scenes to shoot, and we know that music gets added somewhere along the line, but that's about as far as many of us go in post-production knowledge. Actually, the amount of work and artistry that is crammed into that short fourteen weeks is nearly unbelievable.

Editors Take Over

Take, for example, the average feature production here on the 20th Century-Fox lot. The departments that are actively engaged in post-production activity take over immediately at the close of shooting. As a matter of fact, a small amount of what is actually post-production work goes on during the shooting. This would especially be true in case some dubbing or narration were needed and the actor involved had some time away from the set coming to him. By and large, however, the bulk of the work is done after photography closes. Though much of the work we are about to describe is done simultaneously, for purposes of clarity, we will deal with each step individually as we take our hypothetical film through the post-production steps.

Shooting finished, the film editing department under Jerry Webb, takes over. The first man to actually do post-production work on a film is the editor. As the picture is shooting he keeps everything cut and within a few days after photography closes he puts together the "first cut." This finished, it is run for the director who, with the editor, may make certain changes in construction along with effecting a general tightening of the picture. This tightened version, incorporating the director's changes, is then run for the producer who may also make certain changes. Then, given the producer's and director's stamp of approval, the print is run for Mr. Zanuck who may also make changes, eliminate some things, rearrange continuity and possibly decide on some added scenes which are worked out with the director and the producer.

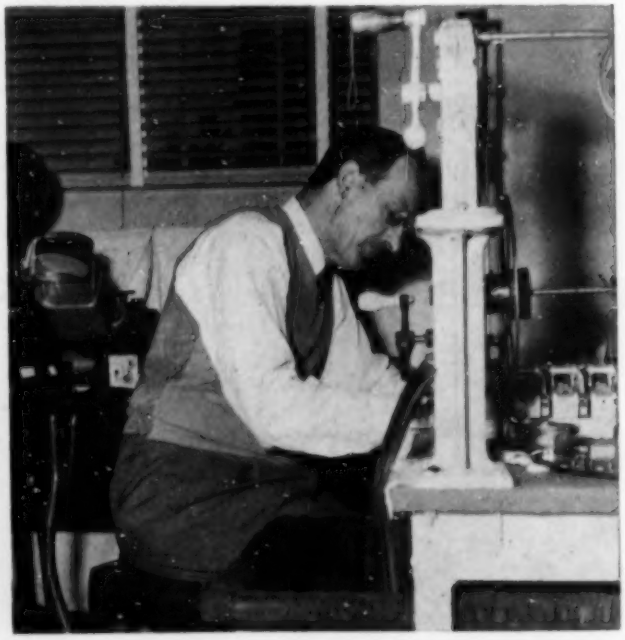
These added scenes are then scheduled as soon as possible so that they may be shot before the cast has scattered and the sets struck. The finished added scenes are incorporated in the picture by the editor, along with all changes, then the final cut is again run for Mr. Zanuck, the producer and the director. Their final approval then sends the picture on to the next phase in the post-production cycle.

Music Is Written

From the print ok'd by Mr. Zanuck a dupe is made which is sent to the music deparment. In the meantime, the composer assigned to the picture has been sitting in with Mr. Zanuck and the producer and director during screenings of the picture so that he has a good idea of its actual construction and sequence arrangement. Alfred Newman and his music department run the dupe, which is studied by Newman and the composer and the music cutters. The picture is run reel by reel and it is decided where, and how much, music is to be used.

The music cutters then break down the picture, timing it out in careful detail, and the composer writes his music to these cues. The music written, it is orchestrated by Ed Powell and the music is recorded to projection to fit the picture.

These recordings then go to the music cutters under Leon Birnbaum



Addition of sound effects such as door slams, crowd noises, etc., is a vital post production activity. These are added to soundtracks on 20th Century-Fox films by sound effects editor Alfred Ross.

Before the musical score for a picture is prepared, each reel must be carefully timed and cued for the composer and the scoring staff. At Fox this is handled by music editor George Adams and assistant Ken Runyan.

and they build the music tracks, synchronizing the music to the action. The impact and artistry that the music department contributes to a picture is almost immeasurable. The only way one could possibly begin to understand what a picture would be without music is to run one that way. It's a shocking experience.

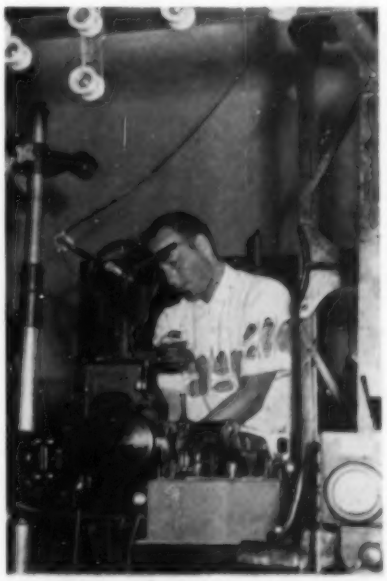
Sound Effects Added

While the Music Department is working on scoring and building the music tracks, the dubbing and sound effects editing department is at work building the effects tracks. Though some of the dubbing is done during production, as we pointed out, the bulk of it takes place in the post-production period. Dubbing is necessitated by a variety of circumstances. Perhaps someone sneezed on the set at the wrong moment or an arc might have started to whine. On location a jet might swoop overhead. To correct any of these or the thousand-and-one other little things that fall in the general classification of "extraneous noises," Walter Rossi and his crew dub the dialogue and cut and fit it to the track. In addition to dubbing, any narration that might be required in a short or feature is done at this point while the narrator watches a print being projected.

One of the most monumental tasks is the sound effects editing this department also handles. Effects editing starts with a series of notes taken when the dupe is run by Rossi and the director and producer. Each of the effects editors is then given one or two reels for which he will build the effects tracks based on notes made during the screening. The tracks are cut and new effects cut and fitted and synced. As many as sixteen separate tracks may be built for a single reel. The effects that are necessary are usually available to the editors in the studio's sound library where millions of feet of track is stored in thousands of categories. However, if the particular effect an editor may require is not in the library, then Rossi and his crew have to create it.

As an example of the lengths to which they go for realism in sound effects, to get the right sounds for the auto racing action in "The Racers" Rossi took a crew to a local sports car race where they recorded the cars roaring past. They even strapped a portable tape recorder to the seat of one of the cars where it picked up all of the sounds that were typical to the interior of a race car as it sped around the track.

While all this has been going on the editorial department has been hard at it on technical work. Laps, fades and other optical effects are created by Jimmy Gordon's optical printing department. Main titles are added and, when necessary, inserts by Bernie Cooper.



All the various soundtracks made during and after the shooting of a picture are finally channeled into the re-recording department, where the "grand finale" of the complicated post-production technical effort takes place. Shown here is Don Rogers, of 20th Century-Fox, threading a re-recording machine.

Dubbed-in dialogue, once it's recorded, is carefully edited and fitted to each reel of film by highly-skilled technicians such as assistant sound editor Duane Hansel.

As each of the post-production departments finishes its work, it is sent to the re-recording department. There, under the careful hand of Warren Delaplain, what is sort of a "grand finale" of post-production effort takes place. The dozens of tracks that have been created for each reel—a skillfully integrated melange of dubbing, sound effects and music are gathered here. The totals for any given reel may run as high as 32 separate tracks. To combine that many tracks for one reel is not only unwieldly but is more than can be recorded at one time. Therefore, the collection of tracks is reduced to what the department calls "combines" or "generations." Usually, these combine the "knowns" or constant elements that are not likely to be changed. This done, the tracks are ready to be re-recorded.

Re-Recording Process

This re-recording step is one of the most impressive and wonderful processes we have ever seen. On the huge platform in Stage 2, the mixers sit at their panels alongside the picture's editor, the director, producer, music director and the sound effects and music editors. It is in this process

(Continued on page 28)

In The

SPOTLIGHT

The function of this department is to provide a forum for the exchange of news and views relative to individual and group activities by members of the organized projectionist craft and its affiliates. Contributions relative to technical and social phases of craft activity are invited.

Candid shot taken at the picnic grounds at Lake Chickamauga Dam during the recent District No. 7 conference. Left to right: E. J. Miller (L. 279, Houston, Tex.), IA representative; A. S. Johnstone (L. 293, New Orleans, La.), 6th IA vice-president; and R. E. "Rut" Morris (L. 142 and 519, Mobile, Ala.), the District secretary.

THE California State Theatrical Federation, comprised of AFL Unions represen.ing 67,000 workers in the entertainment field, adopted a resolution against "runaway" production in foreign countries of filmed commercials for American products designed to be used on American Tv stations. The resolution was particularly aimed at one of the large pharmaceutical houses for producing abroad a series of filmed commercials advertising its products on Tv. This action, according to the resolution, "is an evasion of American Labor standards."

● More than 125 delegates and many visitors attended the 27th District No. 7 convention held in Chattanooga, Tenn., July 27-28. Of the 103 IA Locals in the District (comprising the states of Tennessee, Alabama, Georgia, Florida, North and South Carolina, Mississippi, and Louisiana) only five failed to send delegates to the conference.

IA President Richard F. Walsh and Stanton E. Smith, president of the Tennessee Federation of Labor, were the principal speakers. In his address, Walsh urged that Local Unions lend more generous support to Labor's League for Political Education. He pointed out that a number of states have enacted laws restricting trade unionism. "Labor's friends in the various states must be supported," stated Walsh. . . . "Our lives as unions are controlled by political action, and we must support our interests." Walsh is a member of the executive board of LLPE.

● R. E. "Rut" Morris, secretary of Local 519, Mobile, Ala., was unanimously re-elected secretary of the 7th District, a post he has held continuously since 1923. Morris has been a member of the IA for 43 years, and has served as an International trustee since 1932. He also holds the offices of secretary and business representative for Local 142 (Stagehands) in Mobile. All in all it looks like Morris has a pretty full schedule.

● The newly proposed constitution and by-laws of the amalgamated AFL-CIO and more intensive organization of the Tv field were among the leading topics discussed at the recent IA executive board meeting in Chicago.

● L. J. Patton, popular Eastern division manager for Altec Service Company, and Mrs. Patton recently celebrated their 25th wedding anniversary by a flying vacation tour of the states of Washington, Oregon, and California.

● The 25-30 Club of New York held its first meeting of the season on September 8. A feature of the meeting was the demonstration of the Simplex X-L water-cooled head *(see IP for December 1954, p. 13)*, and the question and answer session immediately following. William Borberg, chief mechanical design engineer for General Precision Lab, was in charge of the demonstration and he more than held his own in answering the many queries thrown his way. Naturally, all the top brass from International Projector Corp. and National Theatre Supply Co. were on hand to help make this a most auspicious evening.

Incidentally, the Club will hold its annual dinner-dance on Sunday, January 8, 1956, at the Hotel Empire, Broadway and 66 Street, New York City.

● The recently-chartered IA Local 855, New Glasgow, N. S., was successfully organized by Sister Local 848, Sydney-

DISTRICT NO. 7 HOLDS ITS 27TH ANNUAL MEET AT CHATTANOOGA

Shown above photographed at the speakers' table in the Convention Hall of the Hotel Patten where the conference was held are, left to right: J. Burton Lowry, president of Chattanooga L. 259 and chairman of the Convention entertainment committee; R. E. Morris (L. 519, Mobile, Ala.), IA trustee and secretary-treasurer for District No. 7; John N. Spearing (L. 511, Jacksonville, Fla.), special IA representative; IA President Richard F. Walsh, and Albert S. Johnstone, (L. 293, New Orleans, La.), 6th IA vice-president and Convention chairman.

Glace Bay, N. S. The New Glasgow Local now has jurisdiction over seven indoor theatres plus two drive-ins.

● A highlight of the banquet recently tendered by Detroit Local 199 was the award of gold life membership cards to ten surviving charter members. Another high spot of the evening was the presentation to the Local of an oil painting of its late business representative, Roger M. Kennedy. This painting, presented by member Jacob Gross, now occupies a place of honor in the Local's headquarters.

Among the invited guests present were IA President Walsh and J. A. Shuff, 8th IA vice-president. Gilbert E. Light, Local 199 president, was the toastmaster of evening. Floyd H. Akins, chairman of the banquet committee, was assisted by Melvin E. Donlon and Edgar A. Douville.

● The New York State Association of Motion Picture Projectionists will hold its annual Fall meeting on Monday, October 3, at the American Legion Club in Syracuse, N. Y. Two sessions are planned for the meeting, with the afternoon session opening at 2 o'clock. Host Local 376, Syracuse, has planned a big day for the delegates, with a midnight banquet winding up the day's activities.

GOLD CARDS TO DETROIT LOCAL 199 CHARTER MEMBERS

Gold life membership cards were recently presented to ten surviving charter members of Detroit Local 199 at a midnight banquet held in the Grand Ballroom of the Federation of Labor Temple in that city. Standing in the back row, second and third from left, are invited guests IA President Richard F. Walsh, who made the presentations, and John A. Shuff, 8th IA vice-president. Front row, left to right: Henry Falk, Edward Foster, Sherman J. Lambly, Wilbur Jose, John J. McDonald, and James R. Powers. Rear, left to right: Timothy J. Kirby, Walsh, Shuff, Lloyd A. Burrows, Earl J. McGlinnen, and D. Cass Newell.

25 Years Ago—September 1930

● An independent survey showed the following breakdown of theatres in the United States wired for sound: *Producer controlled* — Paramount-Publix, 1013; Fox, 601; Warner Bros., 402; RKO, 119; Loew's, 117. *Circuit* theatres not producer-controlled were estimated at 1213. *Independent* houses wired for sound numbered 6769. . . . IA Local 686, Balboa, C. Z., received its charter. . . . William C. Elliott, 1st IA vice-president, pinch-hitted for IA President William F. Canavan, who took a leave of absence to recuperate from recent illness. . . . Howard Hughes' four million dollar production, "Hell's Angels," opened in New York City. This was the first motion picture made with 100% union workers.

● In a recent election conducted by the NLRB, the IATSE, was chosen as the collective bargaining agent for the program employes of Tv station WAAM, located in Baltimore, Md.

● The Circarama showing at Disneyland employs a crew of 18 projectionists headed by chief projectionist Ralph F. Adams, business representative of Local 504, Santa Ana, Calif., and assistant chief projectionist, W. L. Coleman, secretary of the Local.

John A. Shuff, 8th IA vice-president, presenting a portrait of the late Roger M. Kennedy to Detroit Local 199 on behalf of Jacob Gross, who donated the painting.

● No mere lip service does William H. Moran, secretary and business representative for Local 86, Fitchburg, Mass., render to the cause of craft unionism. His labors in behalf of his fellow workers are many and seemingly never ending, but he takes them all in stride. In addition to his duties as an official of Local 86, Moran plays a leading role in the activities of the Fitchburg Central Labor Union, of which he is president; and of the Massachusetts Federation of Labor, in which he was recently re-

(Continued on page 28)

LOCAL 855, NEW GLASGOW, N. S., RECEIVES IA CHARTER

IA charter is presented to the officials of the recently organized New Glasgow Local 855 by Hugh J. Sedgwick, 5th IA vice-president, who presided at the installation ceremonies. Pictured above, front row, left to right: Gerald Davis; Sedgwick; Thomas Davis, L. 855 president; James F. McGuire, business representative, and Robert Emmery, vice-president. Back row: Gerald Phinney; Harold Haley, recording-secretary; John A. McGuire, and George McGrath, treasurer. Local members Douglas F. Smith, financial-secretary, and Charles Archibald, are not shown here as they were unable to be present when the picture was taken.

A Difference of Opinion on "Light-Collecting Speed"

A NEW system to measure the ability of a projection lens to transmit light was recently announced. It depends on a rating known as "light-collecting speed," which is obtained by dividing the diameter of the rear element of a lens by the distance between the rear element and the film. According to Dr. John R. Miles, an optical design engineer who developed this system, the bigger the rear element used in the design of a projection lens, the more light it becomes possible to transmit—even if the other elements do not increase in diameter.

Two opinions follow. In one, Dr. Miles restates his ideas on light-collecting speed which were presented before last Spring's SMPTE Convention. In the second, Mark Stevens examines the light-collecting-speed idea and takes the position that it is neither a valid nor a useful standard for measuring light transmission.

By JOHN R. MILES

Consultant, Projection Optics Co.

THE NEW TERM "Light Collecting Speed" is a useful expression for rating a very important factor in the efficiency of theatre projection lenses previously difficult to specify. This expression describes the ability of the lens to provide adequate illumination to the edge of the screen.

Light collecting speed was defined in the author's paper, presented to the recent SMPTE Convention in Chicago, and is simply equal to the distance of the rear element of the lens from the film, divided by the *used* diameter of the rear element. This is not an arbitrary definition in any sense, because it is the only expression of this type yet defined which indicates the fall-off in illumination for a particular lens, at the edge of the screen.

It is unfortunate that *light collecting speed* should be confused by some with *f* number and *T* stops,* for there is no particular relationship between *f* number and light collecting speed, nor is there any relationship between *T* stop and light collecting speed.

Theatre projectors are in a special category, in which the lamp-house mirror, in practically all cases, controls the *f* number of the projector's optical system. Since the mirror is *f*:2 in nearly all theatre projectors, the speed at which the projection lens functions is *f*:2, regardless of the basic *f* number of the lens. This, of course, assumes that the lens is *f*:2, or faster, and, for practical purposes, we can assume that all modern projection lenses *are* faster than *f*:2.

The fact is that the *f* number "speed" of projection lenses was made faster than *f*:2 in an attempt to improve the edge illumination on the screen, due to the simple observation that a *larger* lens will, by first analysis, pick up more light, and improve this edge illumination. It should be carefully noted, however, that this is not always the case. In fact, it is quite possible that a given *f*:1.7 lens, with a high *T* stop rating, will give less light on the edge *and* the center of the screen than another lens which has a speed of *f*:2 and a lower *t* stop rating. The cause for this seeming paradox is the projection mirror which is *f*:2. (When the faster mirrors of *f*:1.7 etc. are in common use, the same philosophy will apply at the next level of *f* numbers.)

How System Originated

When the writer had the opportunity of selecting the type of basic lens design for the new *super hilux* lenses, manufactured by Projection Optics Co., of Rochester, N. Y., he wanted to overcome the fall-off in illumination, insofar as it was possible. In doing so, he worked out a lens formula which has a rear element as large as the tube of the projectors will allow, and placed as close as possible to the film, still permitting the opening of the film gate on all models of projectors. When these new designs were ready, we used the term, "light collecting speed," to describe this accomplishment.

In order to understand more fully this property of light collecting speed, let us consider a 4-inch projection lens. This lens is *f*:1.5, and is made of six lenses, in which the rear lens element is 1 inch in diameter, and located at a distance of 1½ inches from the film. The light coming from the mirror at the edge of the frame spreads out in a cone, so that approximately half of this edge light goes to the left, and half to the right of a line straight out from the edge of the film gate. Since the film gate is approximately 1 inch wide, and the rear element is 1 inch in diameter, it is obvious that more than half the light at the edge of the frame is lost.

Now, let us take an *f*:1.8 lens, with five elements, where the rear lens element is 1½ inches from the film, but the diameter of this rear lens element is now 1½ inches. It can be seen easily that this rear element will pick up nearly all the light coming from the mirror, actually 5/6 (83%) of the edge light, or a 66% gain in *edge* illumination all due to light collecting speed. The *f* number speed is of lesser value and the *T* stop rating is less, and yet the lens gives more light in the center because of less glass (5 lenses instead of 6), and far more light on the edge because the light collecting speed is high (*f*:1, instead of *f*:1.5).

It would seem that the above examples should prove to anyone that the *light collecting speed* is a very valuable means for specifying the edge illumination factor for theatre projection lenses, when used in a normal theatre.

By MARK STEVENS

I DISAGREE entirely with the use made by Dr. John A. Miles of his term, "light-collecting speed," in rating the efficiency of projection lenses. After studying the paper on the subject presented by Dr. Miles at the Spring Convention of the SMPTE and also reading the article by him published here, I still find the standard *f* system to be the only accurate and reliable means of judging the ability of a lens to transmit light.

Every projector objective lens intercepts a cone-shaped beam of light. Whether or not the cone picked up and utilized by the lens includes all of the light which emerges from the aperture depends upon the size of the lens, its focal length, the size of the aperture, the size of the lamp mirror, and the distance of the mirror from the aperture.

The "faster" (larger) the lamp mirror, the greater the "spreading out" of the cone of light emerging from the aperture—requiring, of course, a faster lens to collect all of it. Now, the real "speed," or light-collecting *power*, of a lens is specified by its *f*-number rating.

The *f*-rating of any image-forming lens is the focal length divided by the open diameter.

The effective open diameter of a projection lens may be greater or smaller than the actual diameter of any particular element of the compound lens—*that* depends upon the optical design of the lens, a matter of little concern to the average projectionist. The important point is that the *f*-speed of a projection lens specifies its light-collect-

*A complete explanation of f numbers and how they are derived, plus a definition of T stop will be found early in the accompanying article by Mark Stevens.

ing efficiency. *There is no other widely accepted specification for this property of a lens.*

A small amount of light may be absorbed and wasted by a projection lens, especially if any of the individual lens-elements be thick, not cemented together, or without anti-reflection coatings. In such cases two different lenses of the same *f*-rating may not transmit and send to the screen equal amounts of light. One lens will give a slightly brighter picture than the other even though both have the same *f*-speed.

In order to specify the actual light-transmission properties of lenses, many optical manufacturers divide their *f*-numbers by the percentages of actual light-transmission and call the results "*T*-numbers." A *T*-number is always slightly greater numerically than the *f*-number of a lens because no lens can transmit more light than it receives. Thus an *f*:2.4 lens which transmits 80% of the light it intercepts within normal working angles is rated as *T*:3.

$$\frac{2.4}{0.80} = 3$$

The concept of *f*-numbers is extremely simple in the case of single-element lenses. As we said, this number is found by dividing the focal length of the lens by its clear diameter. If a lens of 6 inches focus has a diameter of 3 inches, its speed is *f*:2.

$$\frac{6}{3} = 2$$

Calculation of *f*-speeds is very complex in the case of compound lenses, as the focal lengths and diameters of the individual lens-elements cannot be considered separately without taking into account the distances separating them and even their thicknesses! *This is why neither the f-number nor any so-called "light-collecting speed" can be specified on the basis of the diameter and working distance from the aperture of the rear element alone.*

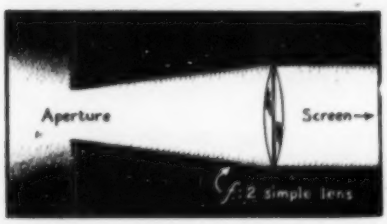
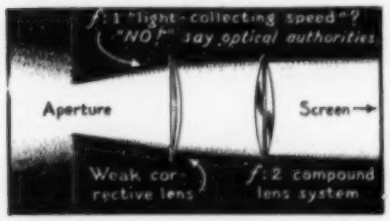


FIG. 1. Interposition of a rear element for improved image definition does not necessarily effect the speed (f-rating) of a projection lens. The term "light-collecting speed" for the rear element alone is misleading. All elements of a compound lens work together and must be considered as a unit. The upper half of this illustration is referred to in the accompanying article as 1A, and the lower half as 1B.



Purpose of Rear Element

We can make the matter clearer. Take a simple biconvex lens, such as the one shown in Fig. 1A. This is drawn to scale to have a speed of *f*:2. Now suppose that the image on the screen is somewhat distorted with this lens. To correct these distortions we interpose a weak meniscus lens between the first lens and the film aperture, as in Fig. 1B.

We now have a compound (2-element) lens: the biconvex lens is the "front element" and the meniscus lens is the "rear element." And it happens that the rear element is so near to the aperture that, *if it did all the work of forming an image on the screen,* it would have a speed of *f*:1. Actually, however, our meniscus lens is very weak and does little refractive work other than "correcting" the action of the biconvex front element. To specify this lens as having a "light-collecting speed" of *f*:1 would be scientifically false.

True, the rear elements of real lenses actually perform a great deal of the image-forming work, but not all nor even half of it. The closer to the aperture they are, the less work they usually do; and they must also function in conjunction with a number of other lens-elements, *one of which* (in the case of a certain modern lens) *is sufficiently concave to counteract the positive refraction of the rear element to a large extent as regards image-formation on the screen!* In such a case the front element does most of the work.

Geometric speed (*f*-ratings), transmission efficiency (either as percent transmission or as a *T*-number rating), and actual performance on the screen are by far the most important things for the projectionist to think about in connection with lenses. An *f*:2 lens which is said to have an *f*:1 light-collecting speed is likely to be no faster and no more "light-gathering" in my opinion than any other *f*:2 lens.

Furthermore, the *f*-rating required of the projection lens for the brightest, most uniformly illuminated pictures depends upon the optical speed of the lamp optical system. This is not to say that the *f*-ratings of projection lens and lamp mirror or condenser should be the same (the lens should have a faster *f*-rating to match a mirror of given speed).

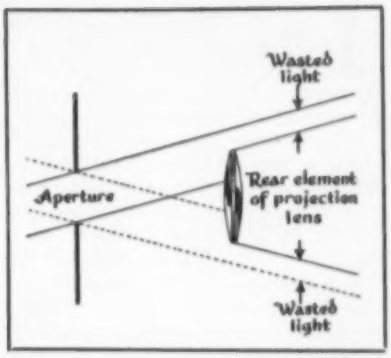


FIG. 2. Rays of light passing close to edges of aperture from opposite edge-zones of large ("fast") mirror overshoot a lens which is too small ("slow") to match the mirror optically. Result: vignetting and hot spot. Most projection lenses, however, are undersize in relation to modern, fast lamp optics, making this diagram indicative of actual conditions.

The geometric speed of any lamp mirror or condenser is an *f*-number obtained by dividing the working distance by the diameter of the component. Thus a 16-inch mirror positioned 32 inches from the aperture has a virtual speed of *f*:2.

$$\frac{32}{16} = 2$$

Now, the speed of projection lens required to match any mirror or condenser does not depend *directly* upon the *f*-rating of the mirror or condenser, but rather upon a complex geometric relationship in which the E. F. (equivalent focal length) of the projection lens and the diagonal of the aperture are among the included factors. To spare the reader a long and difficult discussion, we shall only print the formula which gives the *f*-number of the lens needed to match the lamp optics.

$$f = \frac{Fm}{bF + a(F + m)}$$

In this formula a is the aperture-diagonal (1 inch), b is the diameter of the mirror or condenser, F is the E.F. of the projection lens, and m is the distance of the mirror or condenser to the aperture—all expressed in inches.*

It should be kept in mind that, when projection lens and lamp optics are *perfectly* matched, the projection lens intercepts and utilizes *all* of the light emerging from the aperture, lens absorption and reflection not being considered.

The above formula, while absolutely correct for single-element projection lenses, is also extremely accurate for actual lenses consisting of several lens-

*A complete explanation of this formula and its mathematical derivation may be found in the October 1949 issue of IP, beginning under the heading "The Efficiency Ratio" on page 8.

elements mounted in a tube. It proves beyond doubt that projection lenses must be even faster than the most rapid of available lenses to match perfectly modern high-speed mirrors.

In general, therefore, projection lenses are somewhat undersize in relation to the speed of the lamp optics. What happens when the lens is too small in diameter to match the lamp mirror? As Fig. 2 shows very clearly, many of the rays of light passing through the aperture *close by the edges of the aperture* miss the lens entirely (or, if picked up by the rear lens-element, they fall upon the inner surface of the lens tube and never reach the screen).

Reason for Hotspot

Light is wasted by the undersize lens, that much is clear. Something else equally important is also clear. *The wasted light consists of rays which pass through the aperture close to its edges.* As a result, the edge-areas of the projected picture on the screen are less bright than the middle areas. The relatively brighter middle area is called a "hot spot," while the fadeaway of light at the edges is called "vignetting."

Now let's make our lenses bigger—so big that they pick up *all* of the light coming through the aperture and are perfectly matched to the lamp mirror. This expedient, so easy in imagination, is difficult in practice because many projector mechanisms will not take bigger lenses. Fortunately, for the purpose of discussion, we can establish the same condition of perfect optical match by reducing the diameter of the mirror.

We shall use a smaller lamp mirror. What happens to the vignetting effect now? As Fig. 3 demonstrates, it disappears because all the edge-rays are collected and *sent to the screen* by the lens. The hot spot is gone, and the picture, although not so bright as formerly, is more evenly illuminated.

As mentioned before, the projection lens is a bit too "slow," too small, to match the lamp optics in the great majority of actual cases. Should the reverse condition prevail, however,—the lens being larger than necessary—picture quality on the screen is not affected in any way. It looks just as it does when lens and lamp optics are perfectly matched to one another.

In a case where the lens is actually oversize, all light coming through the aperture is intercepted by the lens; and because the cone of light has the smaller size, the lens is automatically "stopped down," as photographers say. There will be a slight improvement in the depth-of-focus characteristics of the lens, and a possible slight increase in the clarity of the picture. The outer zones of many lenses usually do not function

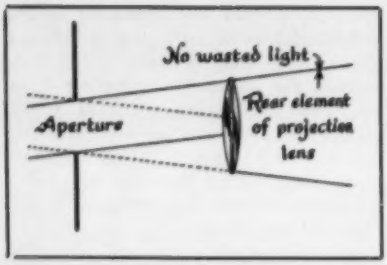


FIG. 3. Reducing the diameter of the mirror reduces total illumination, but it also establishes a condition of optical match with the projection lens. Note that the angles formed by the light-rays are smaller than in Fig. 2. Also note that the lens picks up all of the edge-rays, providing uniform illumination on the screen.

quite as well as the middle zones; and when all the light goes through the middle zones, a clearer image on the screen may be expected. The picture will be considerably less bright, however.

Now even though the biggest lamp mirrors and condensers are somewhat too fast to permit perfect matching with the projection lens—speeds of from *f*:2.0 to *f*:1.5 in the case of most modern lenses—are we to assume that the average projector optical system is unsatisfactory? By no means!

Edge Zones Are Dim

As a matter of fact, the edge zones of the cone of light emerging from the projector aperture are not nearly so bright as the central rays. If the lens fails to pick up and send to the screen all of the outermost rays, the actual loss of light is *very much smaller* than or purely geometric considerations would have us believe. Consequently, vignetting and hot-spot effects are not appreciable with even the biggest and most powerful lamp mirrors.**

The quality of motion-picture projection has improved vastly since the advent of more powerful arc-lamps and faster, coated lenses of advanced design. Projectionists need have no fear of using lamps with the largest-sized mirrors or condensing lenses, and, naturally, the most rapid projection lenses should be used in conjunction with them.

Modern American projection lenses have no peers. Certain foreign lenses may be as good as American lenses, but none is better than, for example, the Snaplite and Super Snaplite lenses of unsurpassed quality made by Kollmorgen, the excellent Hilux and revolutionary Super Hilux series produced by Projection Optics, the well-known and admirable Cinephor and Super Cinephor lenses manufactured by Bausch & Lomb, and the superb Cinema Raptars made by Wollensak. The speeds (light-collecting *powers*) of all these admirable lenses are rated by *f*-numbers.

****Projectionists must guard against vignetting effects caused by shading of the projected beam of light by the front part of the lens-holder or by the hole in the front of the mechanism case when short-focus lenses are used. When such shading does occur, reducing illumination of the edge-areas of the screen image, specially designed lenses are required.**

TESMA Show to Spotlight New Equipment

A close-up view of the VistaVision horizontal projector will be one of the features of the combined convention of the Theatre Equipment and Supply Manufacturers Association and the Allied States exhibitor group, opening on November 6 at the Morrison Hotel in Chicago.

In addition, a double-frame VistaVision print of a forthcoming Paramount feature will be shown at the State Lake Theatre for those attending the convention. A horizontal projector will be on display at the Century Projector Corp. booth on the convention floor.

If the equipment is ready in time for the show, there will also be a display of the new CineMiracle process. This system is similar to Cinerama except that it is operated by means of three projectors located in one projection booth rather than at different points in a theatre. Also on display will be a portable wide-screen Tv projector capable of producing a 20-foot-wide picture. It can be plugged into a 120-volt circuit.

A theatre equipment and new-processes forum, to be headed by Larry Davee, of the Century Projector Corp., will be another important event at the convention.

A partial list of the theatre equipment manufacturers who will exhibit at the convention is as follows: Altec Lansing Corp., Ampex Corp., C. S. Ashcraft Mfg. Corp., Automatic Devices, Ballantyne Co., Bausch & Lomb., Century Projector Corp., Continental Electric Corp., DAWO Corp., Drive-in Theatre Mfg. Co., Eprad Corp., Walter Futter Co., Goldberg Bros., Gordos Corp., Heyer-Schultz Co., International Projector Corp., Kneisley Electric Co., Kollmorgen Optical Co., LaVezzi Machine Works, Lorraine Carbons, Motiograph, Inc., National Carbon Co., National Theatre Supply, Neumade Products Corp., Norpat Sales, Paromel Electronics Corp., Projection Optics, Radiant Mfg. Co., Radio Corp. of America, J. E. Robin Co., Raytone Screen Corp., Strong Electric Corp., Superior Electric Co., Wenzel Projector Corp. and Wollensak Optical Co.

The Focusing Problem

To the Editor of IP:

I consider it just about impossible to focus present-day film and would like to add my emphatic support to the Monthly Chat and the letter by Robert A. Mitchel which appeared in the August issue of IP.

The lens mounts on our projectors are marked, and the focus is written down when we run a picture. This works out fine until you run the picture a second time. The old setting turns out to be useless. You need a different one.

Comes the end of the reel, the second lamp is lit with a slight increase in amperage—the focus changes again. A splice that comes through with a little difference in focus can make it necessary for you to refocus.

On top of that we have constant drifting of the film in and out of focus. Try to keep a picture sharp under these conditions. Mostly, our prints are new, but they still weave in and out of focus. When we run a slightly used, warped print, the situation is hopeless.

Each run of a picture, with the differences in density of the film between indoor and outdoor scenes, make this warping worse. I'd like to see this fellow, Connor, who wrote the complaining letter published in your August issue, find some way to keep up with conditions like these.

P. A. WILLS

Decatur, Ill.

EDITOR'S COMMENT: Here we go again! It's probably obvious to most projectionists by now that the precision of a great deal of equipment now in projection rooms, and most of the camera and laboratory equipment being used in Hollywood is not up to the demands made by the tremendous magnification of the film image on big, wide screens.

The projectionist is forced to take a tiny film image, not sharp enough to start with, and project it at high amperages which are almost certain to buckle the film and keep it flapping in and out of focus. Plus that, he is stuck with the shallow depth-of-focus of the short-focus lenses which the wide screen makes necessary.

Presently available aids in coping with the focus problem concentrate on reducing heat. They include heat filters, water-cooled gates, air blowers, and air jets blasted at the film as it goes by the aperture. None of these alone are a complete or final answer to the problem. The closest thing to an answer has to come from the projectionist himself. He has to keep focusing, focusing all the time—and that's not so easy when you think of his other duties. Conscientious projectionists should be complimented on the patience now required to get anything like a good picture on the screen in a great many theatres.

Understandable Confusion

To the Editor of IP:

I have read several articles in IP and in other magazines on the new Todd-AO process. Some of these say that the Todd process will be made on 65-mm film, and others say that it will be made on 70-mm film. I would appreciate it if you could give the correct information on this matter.

THORNTON MORTENSEN

San Bernardino, Calif.

EDITOR'S REPLY: The reason for your confusion on this point is that you may not have read the articles in question closely enough. However, the subject is, by its very nature, confusing. Both 65-mm and 70-mm film are used in the Todd AO process; 65-mm is used in the camera and 70-mm prints are made for theatre projection. The size of the film image remains the same on the print, but the print has extra area to hold the numerous sound tracks used in the Todd-AO stereophonic sound setup.

More on the Jackson Intermittent

Last month IP carried a most interesting letter from Jose M. Ruiz, of Santa Clara, Cuba, commenting on the article, "A 60-Degree Intermittent Movement," by J. G. Jackson, of Vancouver, Canada, which was published in our February issue. The story concerned an oscillating-cam geneva movement designed to provide the extremely fast pulldown ratio of 5 to 1, thereby making possible practically flickerless projection.

For the benefit of these projectionists interested in projector design ideas, we add the following comment on Mr. Ruiz's letter by J. G. Jackson and by IP.

To the Editor of IP:

Mr. Ruiz's letter was most welcome in furthering the discussion of this intriguing subject. He believes this intermittent to be rather complex for projection. It appears that the American manufacturers tend to agree with him purely from a cost viewpoint. They do not deny its advantages from a mechanical standpoint, but they do not think the advantages warrant the added cost of this equipment.

About IP's comment on the application to 16-mm: During years of research, I gave serious thought to this application and have notes and drawings relating to it. I considered, as does Mr. Ruiz, that the 4-tooth sprocket was too small to be practical. I considered also the use of a 6-tooth as well as an 8-tooth sprocket, but the calculations proved that the movement speed obtained with the extra star slots was too slow.

With an 8-slot star, the resultant speed would not be 135 degrees, as Mrs. Ruiz points out, but works out to the equivalent of a 90-degree movement due to the extra cam speed. The resultant speed is two-thirds of the star to cam ratio, hence two-thirds of 135 is 90. As in my specifications two-thirds of 90 is 60, hence the 60-degree movement.

My notes suggested the use of 2-1 reduction gears between star and sprocket as suggested by Mr. Ruiz. In this case there probably would be some back-lash between gears and I suggested the use of a spring damping device to eliminate this fault. A spring damping unit is used by General Precision in their 16-mm projector to stop back lash in the sprocket. They do not use a geneva movement, but they do use a damping unit. I refer to an article by G. T. Lorance in the Journal of the SMPTE, February, 1950. IP is correct in stating that this movement is adaptable to 16-mm. However, I must admit that extra gearing adds still further to the manufactured cost.

About the eccentric star intermittent. First I would like to refer to two excellent articles which were printed on intermittent movements in 1950. The first was in IP for March 1950, by A. C. Schroeder, and the second in the Ideal Kinema (England), April 1950 by R. Howard Cricks. Both of these learned gentlemen pointed out that the cam pin must enter the star slot tangentially and leave the same way to avoid knocking against the side of the slot. A star that employs non-radical slots cannot avoid this fault. It appears that the eccentric star intermittent was of this nature.

J. G. JACKSON

Vancouver, B.C., Canada

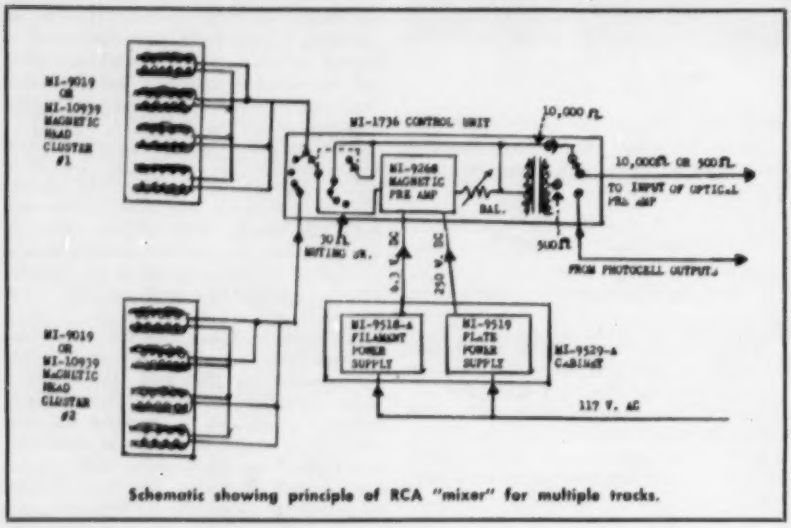
EDITOR'S COMMENT: Mr. Ruiz's remarks are both intelligent and constructive. A 4-tooth intermittent sprocket for 16-mm projectors is certainly much too small for efficient transport of the film.

Our opinion is that the Jackson movement would lend itself admirably to the 8-slotted star suggested by Mr. Ruiz. With the oscillations timed to effect engagement of the cam pin with the slots once every two revolutions of the cam, the 135-degree star-and-cam system would have an effective pulldown of 67½ degrees—a pulldown ratio of 4-1/3 to 1.

Use of cam accelerators also results in serviceable rapid-pulldown geneva movements when starwheels having more than 4 slots are involved. The interposition of reduction gears between the

(Continued on page 27)

RCA Providing 'Mixer' for Magnetic Sound



Schematic showing principle of RCA "mixer" for multiple tracks.

ONE of the largest and newest drive-ins to be erected on the West Coast, "The Big Sky," at Chula Vista, Calif., was recently equipped with an RCA sound system that provides for the mixing of the four CinemaScope magnetic tracks into a single sound channel for broadcast over approximately 2,000 speakers when the theatre is filled to capacity.

Reproducers of this type are now being installed at many drive-ins that desire to take advantage of the quality and greater availability of magnetic CinemaScope prints. They are also attracting considerable interest from indoor theatre owners who wish to use the magnetic prints, but are reluctant to spend the money required for a complete 4-channel installation.

The "mixer" section of the RCA sound system installed at "The Big Sky" is best described in the rough schematic accompanying this article. The illustration shows the PG-932 adaption kit for use with existing optical reproduction systems.

Stereo System Available

The PG-932 has facilities for mounting only one magnetic preamplifier and is for use where there is no intention to later expand into full stereophonic sound with four complete amplifier and loudspeaker channels. Another unit, the PG-391-A can mount up to four magnetic preamplifiers and is intended for those installations which may later desire to expand into a full stereophonic system.

The principle on which the adapter kit works is simple. As can be seen from the schematic, it is necessary only to series-parallel the four pickups of each magnetic head into a single preamplifier and then feed the composite signal into the existing amplifier system. While the stereophonic effect is lost in this process, the method is practical and the results are said to be surprisingly good.

The PG-392 kit consists of a 1736-B control unit which houses a two-stage magnetic preamplifier utilizing a dual triode. The combined signal is fed to the input of the magnetic preamplifier through a changeover switch located at the lower right hand side of the cabinet. An extension rod and auxiliary lever is provided for extending the changeover control to the second projector. The output of the magnetic preamplifier is muted during changeover by means of separate contactors on the changeover switch.

Power Supply

Filament and plate power for the preamplifier is supplied by the MI-9518-A filament power supply and the MI-9519 plate power supply. These two power supplies have sufficient capacity to power four MI-9268 preamplifiers.

An optical-magnetic switch located on the upper left hand side of the cabinet selects either the output of the MI-9268 preamplifier or the output of the photocell and connects it to the input of the existing sound system. A transformer is also provided in the cabinet so that the output of the MI-9268 preamplifier or the photocell may be connected to a sound system having either high or low impedance input.

The PG-391-A kit is essentially similar to the first kit except that it contains facilities for mounting extra preamplifiers for stereophonic sound whenever desired. It has a three-gang volume control, and a separate volume control for the fourth or effects track that can be used when needed.

Kodak Scientist Speeds Design of Fine Lenses

An Eastman Kodak scientist, Dr. Max Herzberger, has been credited with developing a new procedure for lens design which eliminates the need for most of the lengthy mathematical calculations usually required in the making of fine lenses for photography and projection.

This scientific shortcut is essentially a way of analyzing the optical image and considering it as a superimposition, or placing one over the other, of five simple types of images. Each of these images represents one of the five simple types of possible image errors usually found in a lens. From this relatively simple analysis, Dr. Herzberger has been able to determine the design of lenses which solve the most difficult optical problems.

Until now, lens designers, using computing machines, have laboriously traced rays of light through a lens system during the design stage. The new method reduces the job to the tracing of only nine rays, yet by applying Dr. Herzberger's mathematical formulas to this information, it becomes equivalent to the information obtained by tracing as much as 1,000 rays.

To achieve his quick and complete analysis, something sought by scientists during a century of optics research, Dr. Herzberger first learned how to classify image errors for full aperture and for an extended field. These types of errors describe the degrees of symmetry or asymmetry in the image. They also describe the amount of deviation in all directions. The method permits the designer to visualize how the errors are balanced in a given system and thus guides the designer in his aim to obtain a better lens.

The reliability of the new method was checked by use of micro-photographs of tiny points of light as affected by various degrees of the five types of error referred to above. The tremendously enlarged photos proved the accuracy of the mathematics for cancelling out and combining for the best image.

Dr. Herzberger has long been known for his studies in geometrical optics and related research. In the 1920's and early 30's he held important design posts with the famous Leitz and Zeiss companies in Germany. He came to America in 1935 and continued his scientific career at the Kodak Research Labatories.

OBITUARIES

HARRY EIFERT, 65, veteran member of Local 164, Milwaukee, Wis., died July 18 after a lingering illness. He joined the Milwaukee Local in April, 1912, and for the past 22 years worked in the projection room of the Oriental Theatre there. Shortly before his death, Eifert retired under the Local's pension and disability plan. Survivers are his wife, a son, his father, and three brothers. The son, Harold, is a member of Local 164.

ALBERT A. DUBIN, 65, member of Philadelphia Local 307, died recently. He held membership in Local 307 since April, 1917, and worked at the Arcadia Theatre in Philadelphia for 25 years. He served in World War. I. He is survived by his wife.

DONALD LEWIS, SR., and FLOYD A. PUMFORD, members of Detroit Local 199, succumbed to heart attacks within ten days of each other. Lewis, 60, was stricken August 3, and Pumford, 51, died on August 13.

MICHAEL J. OSTROWSKI, 74, member of Buffalo Local 233 since 1911, died July 22 last. A charter member of the Local, Mike Ostrowski was well-known in projectionist circles having worked in a number of theatres in the Buffalo area until his retirement three years ago. He served the Local in various official capacities and at the time of his death held the office of vice-president. He is survived by his wife, three sons who are also members of the Buffalo Local, three daughters, 12 grandchildren.

JOSEPH D. BASSON, 66, IA representative, died September 7 after a long illness. He started his career in the entertainment field back in 1908 when he worked as a motion picture projectionist at the Savin Rock amusement park near New Haven, Conn. During the next few years he worked at nickelodeons in New York City, where he helped organize and became the first president of Local 306, now one of the largest Locals in the Alliance.

Basson was appointed IA representative by President Walsh in 1942 and worked out of the General Office in New York City, taking an important part in negotiations on behalf of film exchange employes and front-of-the-house theatre employes throughout the country. He was also active in organizing Tv technicians.

Survivors are his wife, a daughter, and two grandchildren.

Todd AO Projectors Ready

Todd AO now has sufficient 70-mm projection equipment ready at its Southbridge, Mass., plant to equip 25 theatres. The stockpile is said to include replacement machines and spare parts. Todd AO projectors are built by the Philips company in Holland. They will be used for the first time when the film, "Oklahoma," receives its premiere in New York and Los Angeles sometime next month.

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Are You Listening?

Just What Is Sound?

Arguments generated by the current interest in high-quality sound reproduction often bring into use unfamiliar terms. Following are some definitions, provided by the American Standards Association, which explain terms that many projectionists may be hearing for the first time.

PITCH: Pitch is that attribute of auditory sensation in terms of which sounds may be ordered on a scale extending from low to high, such as a musical scale. Pitch depends primarily upon the frequency of the sound stimulus, but it also depends upon the sound *pressure* and wave-form of the stimulus.

The pitch of a sound may be described by the frequency of that simple tone, having a specified sound pressure or loudness level which seems to the average normal ear to produce the same pitch. The *mel* is a commonly used unit of pitch. It is so defined that a pitch of 1000 *mels* results from a simple tone-frequency of 1000 cycles per second, 40 db above the *normal* threshold of audibility.

LOUDNESS: Loudness is the intensity attribute of an auditory sensation, in terms of which sounds may be had on a scale extending from soft to loud. Loudness depends primarily upon the sound pressure of the stimulus; but it also depends upon the *frequency* and *wave-form* of the stimulus.

Related Sound-Pressure Values

LOUDNESS CONTOURS: Loudness contours are curves which show the related values of sound pressure level and frequency required to produce a given loudness sensation for the *typical* listener.

[NOTE: Aural acuity curve drops off with advancing age, particularly after the age of 45.]

THRESHOLD OF AUDIBILITY (Threshold of Detectability). The threshold of audibility for a specified signal is the minimum effective sound pressure of the signal that is capable of evoking an auditory sensation in one-half of a number of trials. The characteristics of the signal, the manner in which it is presented to the listener, and the point at which the sound pressure is measured *must be specified.*

NORMAL THRESHOLD OF AUDIBILITY: The normal threshold of audibility at a given frequency is the model value of the minimum sound pressures at entrance to the ear canal which produce an auditory sensation in a large number of *normal* ears of individuals between 18 and 30 years of age.

THRESHOLD OF FEELING (Or Discomfort, Tickle, or Pain): The threshold of feeling (or discomfort, tickle, or pain) for a specified signal is the minimum effective sound pressure of that signal which (in one-half of the number of tests) will stimulate the ear to a point at which there is the sensation of feeling (or discomfort, tickle, or pain). Characteristics of the signal and the measuring technique *must be specified in every case.*

HEARING: The per cent hearing at any given frequency is 100 minus the per cent hearing loss at that frequency.

ARTICULATION AND INTELLIGIBILITY: "Per cent articulation" or "per cent intelligibility" is the percentage of the speech units spoken by a talker or talkers that are understood *correctly* by a listener or listeners.

NOTE: The "per cent articulation" or "per cent intelligibility" is a property of the entire communication system: talker, transmission equipment or medium, and listener. Even when attention is focused upon one component of the system (*e.g.*, the intelligibility of a talker, the articulation of a radio receiver) the other components of the system should be specified.

INSTANTANEOUS SPEECH POWER: The instantaneous speech power is the rate at which sound energy is being radiated by a speech source at any given instant.

NORMAL THRESHOLD OF FEELING: The normal threshold of feeling is the accepted value of the threshold of tickle based on measurements on a large number of *normal* ears of individuals between 18 and 30 years of age.

Auditory-Sensation Area

A. Auditory sensation area is the region enclosed by the curves defining the threshold of feeling and the threshold of audibility as functions of frequency.

B. Auditory sensation area is the part of the brain (temporal lobe of the cortex) which is responsive to auditory stimuli (sound).

LEVEL ABOVE THRESHOLD (Sensation Level): The level above threshold of a sound is the pressure level of the sound in decibels above its threshold of hearing for the individual observer.

AIR-CONDUCTION: Air conduction is the process by which sound is conducted through the air in the outer ear canal.

BONE-CONDUCTION: Bone-conduction is the process by which sound is conducted to the inner ear through the cranial bones.

HEARING LOSS (Deafness): The hearing loss of an ear at a specified frequency is the ratio, expressed in decibels, of the threshold of hearing for that ear to the normal threshold.

AVERAGE SPEECH POWER: The average speech power for any given time interval is the average value of the instantaneous speech power over that interval.

Music Terminology

TONE: *A.* A tone is a sound-sensation having pitch. *B.* A tone is a sound-wave capable of exciting an auditory-sensation having pitch. *C.* A tone is a larger successive interval in a major scale.

SIMPLE TONE: *A.* A simple tone is a sound-sensation characterized by its *singleness* of pitch. *B.* A simple tone is a sound-wave, the instantaneous sound pressure of which is a simple sinusoidal function of the time.

COMPLEX TONE: *A.* A complex tone is a sound-sensation characterized by *more than one pitch. B.* A complex tone is a sound-wave produced by the combination of simple sinusoidal components of *different* frequencies.

FUNDAMENTAL TONE: *A.* The fundamental tone is the component tone of lowest pitch in a complex tone. *B.* The fundamental tone is the component of lowest frequency in a complex tone.

OVERTONE: *A.* An overtone is a component of a complex tone having a pitch higher than that of the fundamental pitch. *B.* An overtone is a physical component of a complex sound having a frequency *higher* than that of the basic frequency.

PERSONAL NOTES

J. A. CHILDS, for many years a sound engineering expert with the Altec Service Corp., has been appointed technical supervisor for Todd-AO. Childs now divides his time between the Motion Picture Products Division of the American Optical Co., in Southbridge, Mass., and the Rivoli Theatre in New York City, where he is supervising the installation of the projection and sound equipment for the premiere next month of the film, "Oklahoma," in the Todd-AO process.

* * *

WALLACE BUCHER has been appointed sales promotion manager of the Radiant Mfg. Corp., Chicago, manufacturer of screens for motion picture theatres.

Also appointed by Radiant are GEORGE BAUMANN, as advertising manager and

New Radiant Screen execs: Left to right, Wallace Bucher, George Baumann, and Merrill Natker.

MERRILL NATKER, as assistant advertising manager. Baumann was formerly advertising manager of the Autopoint Co., a division of the Cory Corp., Chicago, and Natker was formerly an advertising agency account representative.

* * *

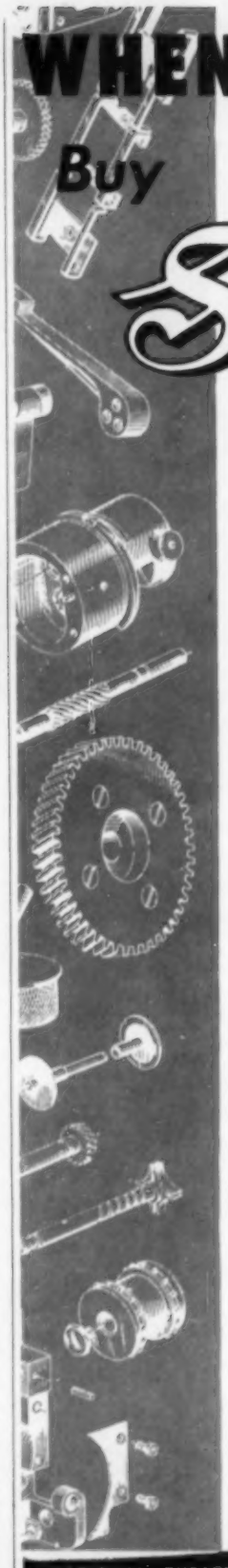
E. S. GREGG, president of the Westrex Corp., is back in New York after visiting company offices in Japan, Philippines, Hong Kong, Thailand, Indonesia, Singapore, Ceylon, India, Pakistan, Italy, and France. He also visited Afghanistan, Turkey and Greece, and presided over a conference of subsidiary company managers held May 30 in Bangkok.

LETTERS TO THE EDITOR

(Continued from page 23)

star and sprocket shafts is not too popular with many engineers, however, because of the likelihood of introducing registration errors.

Mr. Ruiz's remarkably thorough knowledge of a wide variety of projectors is evident from his letter. The Philips EL-5000 soundfilm projector, however, employs a grooved disk movement and a 12-tooth intermittent sprocket. This movement is very reliable and quiet in operation, and it combines the sturdiness and long life of the geneva movement with the accuracy and short-shift period (5 to 1 ratio) of the claw movement.



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SMPTE LAKE PLACID MEET

The continually increasing importance of color motion pictures will be the theme of the 78th Convention of the Society of Motion Picture and Television Engineers, to be held at the Lake Placid Club, Essex County, New York, from October 3 to 7.

The program committee has arranged for ten or more technical sessions dealing with color materials and their uses, high-speed photography and educational Tv. In order that those attending may hear diverse opinions on these subjects, five of the technical sessions will be conducted as panel discussions or symposia.

One of these panel discussions will be on the large screen. It will cover mechanical design, subtended screen angle, picture information, and optics of projection.

The annual awards session will be held on Tuesday; October 4. Winners of the Society's Progress, Sarnoff, Warner and Journal awards for 1955 will be introduced and presented with medals and citations.

$3.60 Top for "Oklahoma"

Todd-AO is following the lead of Cinerama in setting steep admission prices. A ticket to "Oklahoma," when it opens next month at New York's Rivoli Theatre, will cost $3.60 on evenings and weekends. The $3.60 top is standard for Cinerama in New York.

IN THE SPOTLIGHT

(Continued from page 19)

elected vice-president and member of the executive board.

Although he is only 53 years old, Moran has been a member of the IA for the past 31 years. He was elected a trustee of Local 86 in January 1925, and in 1926 served as vice-president. In 1927 he was elected president of the Local, a post he held for the next 12 years. He was financial-secretary and treasurer from 1940 to 1944, and since 1945 Moran has served in his present office as secretary and business representative of Local 86. He has represented his Local at IA conventions for the past six years and was elected a delegate to the 1956—convention.

Moran's latest assignment is his appointment to the public relations committee of the Burbank Hospital in Fitchburg. While serving on this committee, he was instrumental in reducing the hours for nurses and office employes from 44 to 40 hours per week with no reduction in pay. A feather in Moran's cap is his recent election as an incorporator of the Fitchburg Savings Bank, no mean achievement for a union man.

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TECHNICIANS TAKE OVER

(Continued from page 17)

that *everything* audible is finished. Dramatic reality is given life, balance between dialogue and music is established and even voice quality is changed when deemed necessary in order to be more pleasant, or better suited to a particular characterization.

The amount of complex equipment that goes into this process is staggering. Great batteries of re-recording machines and recorders roll in a room adjacent to the stage. On the huge console panel the sound mixers use a myriad of controls, from a wonderful device called a graphic equalizer that makes balance easily *visible* as well as audible, to the three controls that follow the stereophonic voices, and the controls for the fourth or surround track. No detail is overlooked or passed over; perfection is the only standard these men will settle for.

The final recordings are made on the three stereophonic tracks and then the whole is run again and it is decided what is to go on the fourth track. This done, the final four-track recordings are made.

When both the picture and the four-track sound are finished, the next thing that is done is to manufacture a "protective master" (the negative has been cut to match the positive and protective master made by the optical department). This is kept at the studio and the picture negative sent to Deluxe Lab in New York where an answer print is made and immediately shipped to the studio. Here it is striped for magnetic sound by Henry Goldfarb and his crew at the studio's Western Avenue Lab and sound printed. This finished print is run for Mr. Zanuck, the producer and the director. Their final OK sets the New York lab in motion making release prints, and within two weeks the picture is in the theatres.

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BOOK REVIEW

THEORY OF LENSES, by E. W. H. Selwyn, *The Institute of Physics*, 47 Belgrave Square, London, S. W. I., 62 *pages*—5 Shillings.

This compact little book is one of a series intended for general reading by students of physics on a college level. It manages to compress a great deal of information into a small space, and also has the added virtue of using a minimum of mathematics and a great deal of illustration. It is divided into four chapters concerned with the basic theory of light and lenses, and with methods of solving the various problems created by color distortion and aberrations. It is recommended to those who already have some knowledge of optics and math, and desire a compact yet reasonably thorough source of advanced information.

ANAMORPHOTIC SYSTEMS

(Continued from page 15)

similar principle to the cylindrical system.

The collective lens is replaced by a collective concave mirror and the dispersive lens by a dispersive convex mirror. The conditions of focal lengths and separation of components are the same as for lens systems, but the obstruction of one mirror by the other has to be avoided by inclining the mirror surfaces at 45° to the projector axis in the vertical plane. This vertical displacement of the emerging beam introduces mechanical difficulties in some projectors, especially when using short focal length lenses.

The correction of aberration is achieved by the use of mirror surfaces whose sections are not circular. This presents further difficulties in the design and manufacture of mirror systems. This system is just as incapable of providing, in any practicable form, variable expansion ratio as the cylindrical type.

On the question of restoring distortion due to curved screens and projector angle, that applies to all anamorphotic systems. The inclination of the anamorphotic attachment with respect to the axis of the lens does have the effect of curving horizontal lines on the screen, but it is only an *approximate* correction, and other errors are still present.

MR. GUNN: Assuming one has the best optical equipment available, and leaving aside any desire to imitate Cinerama, for example, and questions of screen reflectancy, is there anything to be said in favor of using the curved screen, *purely from the optical point of view?*

MR. COOK: The only thing in its favor is the polar curve of reflection from the screen. We have had a spasm of 3-D projection which has required the use of metallic screens with high reflectivity. The difficulty is that if you have a flat screen with

Clark Gable and Jane Russell in "The Tall Men," 20th Century-Fox CinemaScope production.

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a wide-angle anamorphic projection, the polar curve at the edge of the screen is reflected away from the auditorium, and viewers on the opposite side of the theatre will see a poorly illuminated picture. By choosing a suitable screen curvature, the same polar curve from the same screen material can be reflected back in the desired direction.

Apart from that consideration, *there is no advantage in the use of curved screens, from an optical point of view.*

MR. HIGGINS: I have looked up "anamorph" in Webster's dictionary. The word does not appear there, but the definition of anamorphosis is "a distorted or monstrous projection of representation of an image."

Cylindrical Lens Advantage

Mr. Cook has pointed out the advantages of the prismatic anamorph, but we have all seen in the trade press accounts of trials in which it seems to be a general verdict that the cylindrical has certain advantages over the prismatic. Will Mr. Cook kindly enlarge on this?

MR. COOK: I think what you have seen this evening should enable you to judge whether, from the point of view of definitions, there is any difference between prismatic and cylindrical systems. There are, however, one or two purely mechanical considerations which arise in rather unusual cases, under extreme conditions of screen sizes and projection distances.

Where very short focal length lenses are required, the projection lens is sunk right down into the body of the projector, and unless the anamorphotic attachment is positioned closely to it, the amount of oblique light passing through the attachment will be greatly reduced, and there will be a fall in illumination at the sides of the screen. In this application, the cylindrical type has the advantage that it can go down into the body of the projector.

The second advantage lies in the fact that cylindrical attachments can be made in the larger sizes demanded by wide-beam diameters emerging from projection lenses of extremely long focal length and wide relative aperture. This is an unusual type of condition arising, for example, in Drive-In theatres, and the volume of glass and its cost in a comparable prismatic attachment is quite prohibitive.

Light Transmission Similar

MR. BLAND: Mr. Cook was speaking about the added requirements by way of performance of the projection lens which brought up the added distortion shown by the anamorphotic lens system. The performance of the new lens was improved, but it did seem to me that there was a loss in luminance, and the screen brightness did not seem so great. Is that possibly because there are more glasses in it, the number of glass-air surfaces causing the trouble?

MR. COOK: There might be a very slight difference, but it is very difficult to keep these two projectors running at a constant brightness, and I think the loss of luminance you noticed might be due to projection conditions. Laboratory tests indicate that the light transmission through the two types is very similar.

MR. BLAND: On the question of the reflecting screen, I have always had the impression that when one went to CinemaScope proportion in large theatres, the trouble was to find enough light. One is forced to use a reflecting type of screen, and therefore a curved screen is essential. Apart from this consideration, would you say that the image is better on a flat or curved screen?

MR. COOK: From the optical point of view, the flat screen is ideal, but on the other hand the screen has to be curved very considerably before definition troubles become apparent.

MR. CRICKS: Would an answer be to curve the projector gate?

MR. COOK: There might be a case for a curved projector gate. There, one must consider two types of curvature, spherical or cylindrical. From the optical point of view, the spherical curvature would be the easier to deal with, but it would require special projection equipment. I would not like to say that any existing equipment would act in that way.

The cylindrical curvature is very difficult to deal with in normal spherical lens systems. It is possible that some useful answer might result from experimentation, but it is problematical whether or not it would be worth while attempting.

MR. LEEVERS: Mr. Cook in his calculations comparing the light efficiency of the mask gate and the anamorphotic system, referred to lens efficiency of 70% for the prismatic anamorph. Can he perhaps give us the equivalent figure for the cylindrical type?

MR. COOK: I cannot tell you the figure off-hand, but by the nature of the construction the transmission is a little better. I doubt whether this difference would ever be noticeable under conditions existing in normal projection rooms.

Theatre Conditions "Appalling"

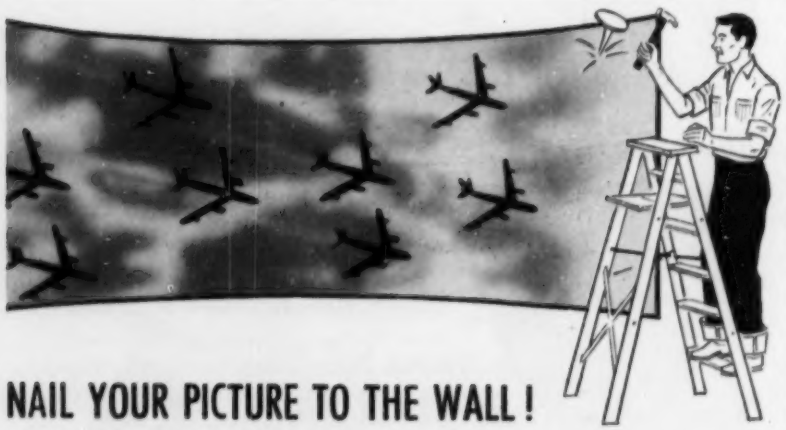
MR. GUNN: Can you touch briefly on the effect of the projection beam not being normal to the screen and what effect this has?

MR. COOK: I am appaled at conditions in some theatres. Assuming a projector axis inclined at 25° to the horizontal and the lens system focused in the centre of the screen, the top and bottom of a 20-ft. high screen is displaced from the ideal plane of best focus by about 4 feet. Furthermore, the geometry of the image is distorted by change of aspect ratio and keystone distortions.

MR. CRICKS: There is a German projector, necessitating tilting, which is claimed to be suitable for wide screen.

MR. COOK: The correction of keystone distortion is possible by an appropriate relationship between the inclinations of the projector and projection lens axes. Since this is achieved at the expense of focusing considerations for all parts of the screen and fails to correct curvature of straight lines, it is likely that the projector referred to includes tilted anamorphotic attachments.

[THE END]



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STEREOSOUND SYSTEM

(Continued from page 14)

reproducer, using material recorded from a previous selection. The center speaker output then seemed to be much louder than that of the binaural system, and would almost drown out the left and right speakers. By reverting to the "normal" operation as a delay mechanism, the center speaker's output became almost unnoticeable, even though its sound level was greater than the combined levels of the left and right speakers.

The greatest usefulness for this proposal would seem to be in motion-picture theatres, in which centrally located speaker systems of adequate power capacity already exist. To add a 2-channel stereophonic would mean adding two loudspeakers (right and left) of smaller power-handling capacity, and a method of delay for the signal to be radiated from the center loudspeaker.

If, for example, the motion-picture film uses two soundtracks for the two channels, side by side, then a sound pickup unit could contain the two photocells for the right and left tracks, and a third photocell, which scanned both tracks, spaced sufficiently far behind the other two to provide the required delay. If a standard soundtrack were played, the third photocell would act as the regular sound pickup means, and the right and left speakers would not change the illusion that the sound was centrally located as in an ordinary system.

2 out of 3 Families Have Tv

Two out of three American households now have at least one Tv set, the Bureau of the Census reports. 32,000,000 households own one or more receivers.

DISNEYLAND PROJECTION

(Continued from page 11)

When the fresh bulb, which has been in the rear of the housing, makes contact, the relay snaps back to its original position, and the blacked-out section of the picture returns to the screen. The entire action takes less than two seconds.

4-Channel Magnetic Sound

Sound for Circarama is recorded on four magnetic channels, but it is not synchronized to the projectors as this is not necessary in the travelogue type of presentation. The sound is carried to speakers mounted beneath each projector. It is possible to fill the little theatre with sound from all the speakers or to give the sound an added directional quality through selective use of the speakers. The sound reproducer was manufactured by Kinovox, and installation and servicing has been handled by Altec.

The approximate focal length of the lenses used for Circarama is 1⅛ inches, but some leeway is needed in focal length to adjust the images exactly in relation to each other and

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for CinemaScope

the individual screens. This leeway is obtained by using variable-focus "Expanso" lenses manufactured by the Pacific Optical Co.

The camera system for shooting the Circarama show presented fewer problems than the projection system. Eleven of the Cine Kodak 16-mm

The Circarama cameras are shown above mounted on a platform so that each of the eleven cameras covers one segment of a complete circle. Most of the shots were taken with the above rig fastened to the top of an automobile.

cameras were mounted on a turntable so as to point in all directions and then synchronized to each other. The cameras were activated by eleven separate drive shafts linked together in sync by means of a sprocket chain.

Most of the sequences were photographed at 24 frames per second, but one special scene was photographed at eight frames per second to give the illusion of speeding down Willshire Boulevard in Los Angeles at 90 miles per hour. The sequences were usually photographed with the turntable rig fastened securely to the top of a station wagon. All sequences were shot on Commercial Kodachrome film.

"Trip to the Moon"

Another Disneyland feature that makes imaginative use of motion pictures and special sound effects is the "Trip to the Moon," sponsored by Transworld Airlines. After being "briefed" for 15 minutes in another small theatre by means of a film that describes what rocket ships and interplanetary travel will probably be like, "passengers" are conducted by a TWA hostess into a room built to resemble what experts believe the interior of a rocket ship will look like 50 years or so from now. The "trip" to the moon is accomplished by means of synchronized rear projection into two "scanners" inside the "rocket ship."

A narrator introduces himself as a TWA captain and explains that the first 42 seconds of the flight will be too noisy for conversation due to the rushing tail blast. Then he announces

Circarama's electronic nerve center. The control panel at left signals automatically when the film breaks or a bulb burns out on any of the projectors. The control unit makes a complete electronic test after each presentation to insure that all units are in working order before it frees the mechanism for the next showing. The unit at right is the Kinevox Sound Reproducer.

that the ship has passed the speed of sound and will shortly reach a velocity of 38 miles per second.

Background sound effects provide realism. The audience hears the radio from the tower, then the sound of the "blast off," radio bearing signals and additional rocket thrusts. The "captain," acting as if all this were normal, carries on his narration of the flight.

Powerful Illusion Created

While the "passengers" feel an artifically-stimulated vibration of their seats, they watch the "scanner" in the center of the floor. This is actually a rear projection movie screen. They see the flame of the rockets and the receding Southern California coast line. Then they look up at another "scanner" above their heads to watch the space ships progress through layers of clouds and into the outer atmosphere. Through the scanners they watch the ship circle the moon and return to earth. A small plastic model of the moon, reproducing craters and other landmarks as faithfully as possible was used in filming this sequence.

A third attraction at Disneyland which makes effective use of motion pictures is a show sponsored by the Richfield Oil Co. A CinemaScope cartoon presents a capsule history of how the earth was formed billions

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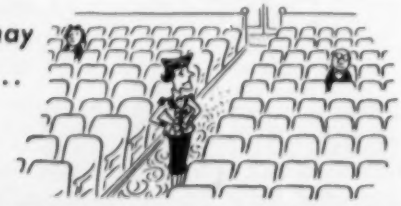

BUT EVERY PERFORMANCE STILL MUST BE PERFECT!

A perfect performance calls for equipment that rolls in top shape from earliest matinee to midnight show. The best man to keep it that way is an expert RCA Theatre Service Engineer. And he's the *only* man who's backed by all the broad technical resources of RCA.

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of years ago and what has gone on since beneath its surface.

When the cartoon comes to a close, the houselights are automatically switched on and a recorded narration describes the second part of the presentation — another rear projection deal, but this time into a dome-shaped screen that rises from the floor and might be said to resemble the end quarter of a water melon enlarged a great many times. Two synchronized projectors inside the dome project on its surface a graphic explanation of oil-bearing geological formations and new drilling methods.

It is interesting to note that these shows or exhibits were produced jointly by Walt Disney and the interested business organizations — American Motors, TWA, and Richfield Oil. The companies are reported greatly pleased by the advertising and publicity they receive. It may be that presentations of this kind will become widespread before long. If so, they will provide added employment opportunities for trained projectionists. Despite the striving for automation in setting up the shows, trick projection effects cannot be properly handled by amateurs.

TRENDS IN SHUTTER DESIGN

(Continued from page 8)

loss of light occasioned by the shutter is sometimes greater than 50%. The edge of a shutter blade must cut through the light beam with great rapidity to permit maximum transmission values to be attained. Single-rotor fan-type rear shutters cut the light rather slowly, and hence require blades so wide that from 53%, or even more, of the light can be wasted. The cylindrical type of shutter is preferred by some because it is double-acting, the edge of one opening cutting down into the light beam while the corresponding edge of the opposite opening cuts up into the beam.

The claw intermittent movements used in many 16-mm. projectors provide more rapid film-pulldowns than the 3:1 geneva movements of 35-mm. theatre machines. These more rapid movements permit narrower shutter blades to be used for less light loss. The pin-cross movement of the Powers 35-mm. projector was a satisfactory sprocket intermittent having a 5:1 pulldown ratio. Any intermittent movement as quick-acting as 5:1 permits the alternative use of two distinctly different shutters: a 2-blade shutter for increased light transmission and a 3-blade shutter for increased freedom from flicker at extremely high levels of screen illumination.

5 to 1 Intermittent

The 2-blade shutter for 5:1 intermittents has the usual cutoff frequency of 48 cps., but blocks only 33 17/20% of the light, passing fully 66 3/20%. The 3-blade shutter, on the other hand, has the same transmission as the ordinary 2-blade shutter for 3:1 intermittents, but because there are two equally spaced balancing cutoffs instead of one, the cutoff frequency is 3×24, or 72 cps. See Fig. 1.

Highlight brightness may be increased to several hundred footlamberts without perceptible flicker when cutoff frequency is 72 cps.

Three-blade shutters can be used successfully only with 5:1 or faster intermittents, never with ordinary 3:1 geneva movements. Special accelerated geneva movements have been constructed to furnish 5:1 and 7:1 pulldown ratios. One of the best arrangements is the oscillating-cam movement designed by J. G. Jackson of Vancouver, B.C. (IP for February 1955, p. 7).

Shutterless Projectors

Because the standard occulting shutter wastes so much light, several shutterless experimental projectors have been constructed, a few of which have enjoyed limited commercial use. Shutterless projectors are also without intermittent movements, the combined function of intermittent-and-shutter system being performed optically by means of moving mirrors,

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lenses, or optical prisms. One such machine is the Mechau projector developed in Germany before the war.

The chief disadvantage of a "continuous" projector such as the Mechau is the complicated system of rotating and oscillating mirrors, the maintenance and repair of which is difficult. A simpler kind of continuous projector utilizing only a multifaced revolving prism directly in front of the aperture is now coming into use for commercial TV film pickup.

Until a really simple and trouble-free continuous projector is manufactured for the theatre, the conventional intermittent-and-shutter type of machine will continue to dominate this field. Improvements in the shutter may be expected from time to time, bringing the working efficiency of this component closer to the theoretical limit of 50% light transmission without travel ghost for 3:1 intermittent systems.

As stated previously, the single-rotor fan-type rear shutter is not entirely satisfactory. The rear-and-front combination represents a moderately successful attempt to increase the efficiency of this shutter, but is physically unwieldy. The old-style front shutter was fairly good because it could be positioned in the plane of the "aerial image" of the arc mirror or condenser, the narrowest, or most constricted, part of the light beam. The aerial image is always formed in front of the projection lens, and its diameter is independent of the diameter of the lens.

Reducing Heat on Film

Modern projection requires the shutter to be placed between the lamphouse and the mechanism to reduce heating of the gate and film. The double-rotor fan-type rear shutter, although mechanically complex, is an improvement over earlier fan-type rear shuttters, inasmuch as the two rotors or "fans" revolve in opposite directions and cut through the light beam twice as fast.

The cylindrical, or barrel-type, shutter used in the Motiograph is regarded as highly efficient. This is invariably placed behind the aperture, and hence possesses the cooling advantages of other rear shutters. It is double-acting, and accordingly cuts the beam very rapidly. Most cylindrical shutters of European manufacture contain automatic fire fins which operate by centrifugal force, thus eliminating the need for a fire-shutter arrangement geared to the mechanism.

The 2-blade "dished," or conical, shutter as used in the Simplex XL has a transmission efficiency as high as that of the double-acting cylindrical shutter. The conical shutter is placed close to the aperture where it effects very rapid cutoffs. Better still, in the writer's opinion, is the 1-blade conical shutter which revolves twice as fast as a 2-blade conical shutter of similar size.

The "Silent" Days

It is of interest to note that the normal rate of film travel for silent pictures was 16 frames per second. The shutter cutoff frequency was then 32 cps., tolerating a highlight brightness of only about 2 footlamberts, equal to a screen brightness level of about 4 footlamberts. At higher brightness levels pronounced flicker was visible.

The high brightness levels of Tv picture tubes require a much more rapid "field rate" than the shutter cutoff frequency employed in sound motion pictures (48 cps.). Indeed, the highlight brightnesses encountered in home Tv sets range from 15 to 150 footlamberts, corresponding to motion-picture screen illumination levels of 30 to 300 footlamberts. Experience has shown that the field rate should be at least 40 cps. for the 15-footlambert highlight level, and at least 60 cps. for the 150-footlambert highlight level.

Shutters for Tv

A field rate of 60 cps. was selected for Tv transmission in American practice, not only because it is rapid enough to make flicker imperceptible at the higher brightness levels, but also because it corresponds with the alternating-current frequency of commercial power in the United States.

Adoption of a 60-cycle field rate ("frame rate" of 30 per second for interlaced scanning) introduced difficulties in the transmission of motion-picture films which, of course, are photographed at 24 frames per second. To have increased the projection speed to 30 frames per second would have had adverse effects upon sound reproduction.

These difficulties were obviated by film-reproducing systems which functioned in an unusual manner. To resolve the difference between the motion-picture film rate of 24 frames per second and the Tv field rate of 60 scannings per second, a special timing was introduced to provide an average of 2½ scannings per frame of film: 24 frames × 2½ = 60 fields.

[TO BE CONCLUDED]

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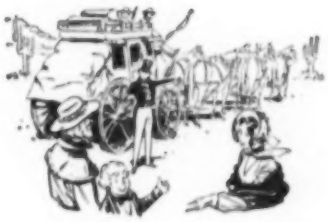
When the gun failed, they used a tablespoon



HE LEARNED acting the hard way, barnstorming frontier towns by barge and stagecoach, playing in sheds and taverns.

One night in Houston, a Texan even suggested the troupe tour through Indian country, carrying their stage weapons for protection. Joe Jefferson declined. He later said he had shivered when he imagined himself facing a hostile Indian and armed only with a stage pistol whose tendency to misfire had several times "compelled our heavy villain to commit suicide with a tablespoon."

By the 1860's, Jefferson was America's favorite actor. When he played his famous Rip Van Winkle (see picture), "one-night" towns declared a "Jefferson Holiday." Business stopped, schools closed, so that everyone could get a chance to see him act.

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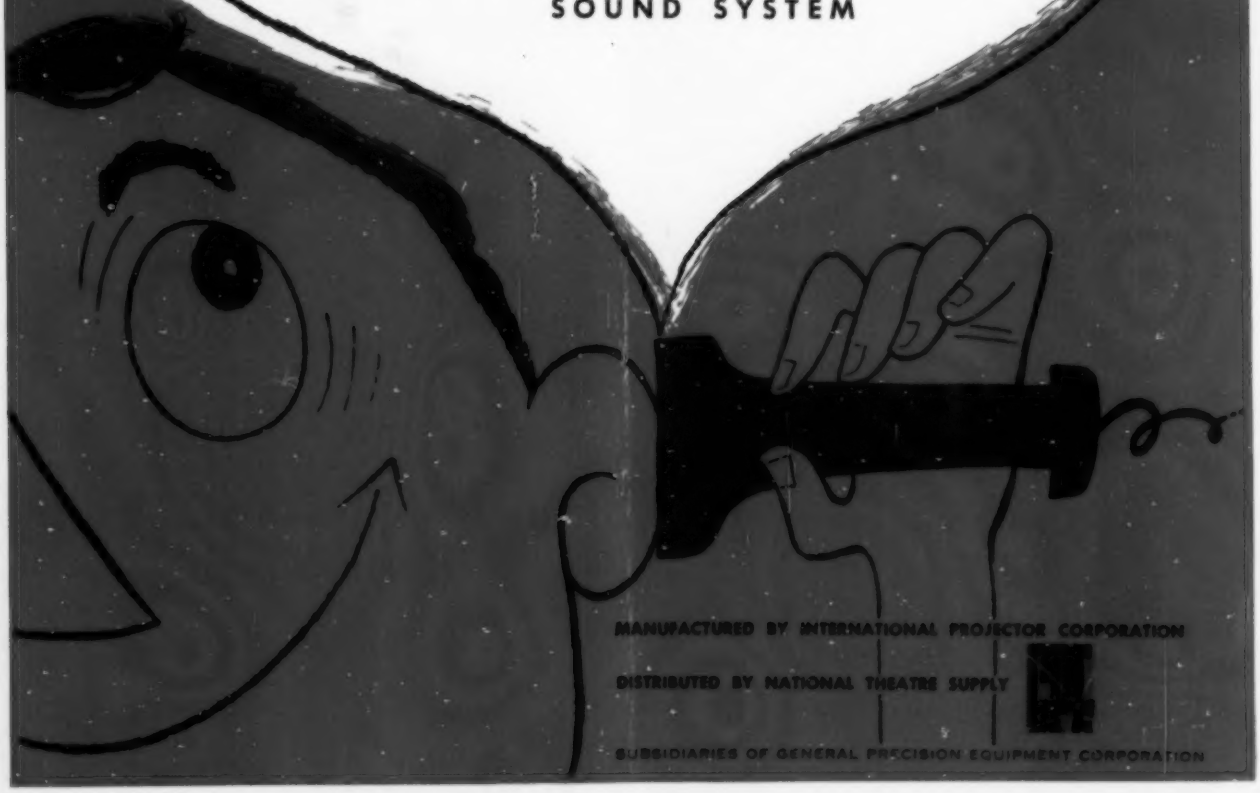

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